Delaware Ambient Air Monitoring
2020 Network Assessment

Division of Air Quality

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Executive Summary

40 CFR Part 58.10(d) requires Delaware to perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in Appendix D of this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and where new technologies are appropriate for incorporation in the ambient air monitoring network. This report serves as Delaware's 2020 assessment under this requirement.

For this 5-Year Monitoring Network Assessment (Assessment), the Division of Air Quality (DAQ) performed a technical review of the data collected in the ambient monitoring network. To conduct this review, DAQ performed the following:

a. Population data was summarized for all three counties in Delaware. This information was used to determine the appropriateness of monitoring for population exposure.
b. Meteorological parameters were reviewed to establish upwind / downwind relationships between a monitor site and surrounding emission sources.
c. Emission inventory summary data was reviewed. This information was used to determine if a monitor is sited appropriately to represent maximum pollution concentrations or specific ambient source impacts quantification.
d. Historical data collected at each site was reviewed for trends and comparison to the current National Ambient Air Quality Standards. This is helpful to determine if Delaware is achieving air quality improvements and meeting air quality standards.
e. Site by site correlation analysis was performed using tools supplied by EPA for appropriate monitors. This information is used to determine if information collected at sites is redundant and if the site may be considered for elimination.
f. A bias calculation was performed to determine impacts that may occur if a monitor is removed from the network.

DAQ evaluated the data from this technical review according to defined performance measures. We also expanded performance measures beyond application of this technical information. Performance measures were organized into the following categories:

a. Data Criteria
b. Statistical Criteria
c. Situational Criteria
d. Future Needs and Special Considerations

Specific performance measures used in this Assessment are detailed in the Delaware Air Monitoring Network – Current Network Description section. Not all performance measures were applicable to every monitor / site. Based upon the evaluation of these performance measures, DAQ determined the importance (critical, credible, marginal, new site required) of each monitor in the network:

- **Critical sites** are of high value and will be continued.
- **Credible sites** are expected to continue but may not be the design value location at or above the NAAQS.
- **Marginal sites** or **monitors** are subject for removal or movement.
- **New site required** represent potential areas of investment.

Results

The results of this Assessment indicate that the network contains only critical or credible sites. Issues that may impact future network design include new monitoring requirements associated with new or revised NAAQS, aging equipment/maintenance issues, and resource availability. When any future monitoring rules are promulgated, Delaware will work closely with EPA Region 3 to ensure that all new monitoring requirements are met.

Introduction

In 1970, Congress passed the Clean Air Act that authorized the Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for pollutants shown to threaten human health and welfare. Primary standards were set according to criteria designed to protect public health, including an adequate margin of safety to protect sensitive populations such as children and asthmatics. Secondary standards were set according to criteria designed to protect public welfare (decreased visibility, damage to crops, vegetation, and buildings, etc.).

Seven pollutants currently have NAAQS: ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$) and lead (Pb). These are commonly called the "criteria" pollutants. When air quality does not meet the NAAQS, the area is said to be in “nonattainment” with the NAAQS.

In October 2006, the EPA issued final regulations concerning state and local agency ambient air monitoring networks. These regulations require periodic assessments of the monitoring networks including the information as described in section 40 CFR Part 58.10 (d) annual monitoring network plan and periodic network assessment, which states:

> *“The State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and where new technologies are appropriate for incorporation in the ambient air monitoring network. The network assessment must consider the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma), and, for any sites that are being proposed for discontinuance, the effect on data users other than the agency itself, such as nearby States and Tribes or health effects studies. For $PM_{2.5}$, the assessment also must identify needed changes to population-oriented sites. The State, or where applicable local, agency must submit a copy of this 5-year assessment, along with a revised annual network plan to the Regional Administrator. The first assessment is due July 1, 2010.”*

This monitoring network assessment document is written in compliance with this directive.

Delaware Air Monitoring Network - Current description of monitoring network

The current air monitoring network in Delaware consists of 11 sites throughout the state.
40 CFR Part 58, Appendix D, includes the following objectives and types of sites:

1) Three main monitoring objectives:
   a) Provide air pollution data to the public in a timely manner
   b) Support compliance with ambient air quality standards and emissions reduction strategies
   c) Support air pollution research studies

2) Six general site types needed to achieve the 3 main objectives:
   a) Maximum concentration
   b) Population exposure
   c) Source impact
   d) Background
   e) Transport
   f) Welfare-based impact (visibility, vegetation, etc.)

Appendix D also discusses scales of representativeness and other specific network design criteria, including the NCore network and pollutant-specific requirements. Delaware's monitoring network complies with all requirements in 40 CFR Part 58 and all appendices.

Table 1: Delaware's Current Monitoring Network

Site Name & AQS ID	Parameter	Start Date	Objective
Killens Pond 10-001-0002	O_3	4/1/1995	General/ Background
	$PM_{2.5}$	1/1/1999	General/ Background
	WS/WD	4/1/1995	
Dover 10-001-0003	$PM_{2.5}$	1/1/1999	Population Exposure
Brandywine 10-003-1010	O_3	7/1/1994	Population Exposure
	WS/WD	11/1/2013	
Bellefonte II 10-003-1013	O_3	4/1/2001	Population Exposure
	SO_2	3/1/2003	Population Exposure
Bellefonte I 10-003-1003	$PM_{2.5}$	1/1/1999	Population Exposure
MLK 10-003-2004	SO_2	1/1/1999	Population Exposure
	CO	1/1/1999	Population Exposure
	NO_2	1/1/2001	Population Exposure/ Maximum Concentration
	NOy	1/1/2011	Population Exposure

Site Name & AQS ID	Parameter	Start Date	Objective
MLK 10-003-2004 (continued)	O_3	1/1/2011	Population Exposure/ NCore
	$PM_{2.5}$	1/1/1999	Population Exposure/ Maximum Concentration
	$PM_{2.5}$ speciation	6/1/2001	Population Exposure/ NCore
	PM_{10} (Local Conditions) and PM_{coarse}	1/1/2011	Population Exposure/ NCore
	BC	1/1/2001	
	VOCs	1/1/1999	
	Metals	1/1/2003	
	WS/WD	6/1/2000	
	Temp/RH	1/1/2011	
Newark 10-003-1012	$PM_{2.5}$	12/15/1999	Population Exposure
Lums Pond 10-003-1007	O_3	1/1/1992	Upwind Background/ Population Exposure
	SO_2	1/1/2000	General Background/ Population Exposure
	$PM_{2.5}$	1/1/1999	Regional Transport/ Population Exposure
	WS/WD	6/1/2013	
Delaware City (Route 9) 10-003-1008	SO_2	2/1/1992	Population Exposure/ Source Oriented
	$PM_{2.5}$	6/1/2013	Population Exposure/ Source Oriented
	WS/WD	5/1/2011	
Seaford 10-005-1002	O_3	3/1/1990	Population Exposure
	$PM_{2.5}$	1/1/1999	Population Exposure
	WS/WD	5/1/2011	Population Exposure
Lewes 10-005-1003	O_3	5/1/1997	Population Exposure
	SO_2	1/1/2013	Population Exposure
	WS/WD	6/1/1997	
11 Total Sites – 12 Different Parameters			

Table 2: Most Recent 3-Year Air Quality Summary

Pollutant	Status of NAAQS and major Risk Issues in Agencies Network	Extent of NAAQS Violations (list cities violating NAAQS)	Days above 100 on the AQI	Contribution to Downwind Violations?[a]
O_3	Non-attainment	New Castle, Kent, and Sussex Counties	19	New Castle County - Philadelphia CBSA
CO	Attainment	NA	0	NA
SO_2	Attainment current annual NAAQS	NA	1	NA
NO_2	Attainment current annual NAAQS	NA	0	NA
$PM_{2.5}$	Attainment current annual and daily NAAQS	NA	3	NA
PM_{10}	Attainment current daily NAAQS	NA	0	NA
Pb	Attainment current NAAQS	NA	NA	NA

[a] Identifies the Delaware county adjacent to a CBSA in the next downwind State violating the NAAQS

Major factors for network assessment:

- The highest priority monitors are those for pollutants with recorded observations that are close to or exceed the NAAQS levels in Delaware. For the most current 3 years of data, 2017 – 2019, O_3 observations continue to exceed the NAAQS, although the current Design Value meets the NAAQS and is trending downward. $PM_{2.5}$ meets the current 24-hour and annual average NAAQS although values are still >50% of the NAAQS and on rare occasions observations may still exceed.

History of air monitoring in Delaware

Delaware is located within the northeastern portion of the Delmarva Peninsula and is the second smallest state in the nation with a total area of 1,982 square miles. Delaware is 96 miles long and varies from 9 to 35 miles in width. It is bordered by Pennsylvania to the north, Maryland to the west and south, and New Jersey to the east. Delaware is composed of three counties, from north to south these are New Castle, Kent, and Sussex.

Most of the land area in Delaware is part of the coastal plain. The exception is the northernmost portion of New Castle County which includes the rolling hills of the Piedmont area. The highest elevation in the state is approximately 450 feet.

Air pollution monitoring in Delaware began in the 1950s, prior to the establishment of the US EPA. The first monitors were simple mechanisms or passive collectors such as dust-fall buckets and tape samplers, and often operated for limited time periods. These were followed in the 1960s by wet-chemistry instruments, which were soon replaced by more advanced electronic instruments and the establishment of permanent monitoring stations. The addition of computer technology in operating monitoring systems and air pollution data collection in the late 1970s and early 1980s was critical to the development of the core monitoring network that exists today.

The earliest monitors were placed near pollution sources to measure direct impact of pollution emissions. As ambient air pollution standards became established and monitoring methods standardized, the monitoring network expanded to include monitors in both urban and suburban areas. Monitoring goals shifted to include measuring high pollution concentrations in population centers, detecting trends, and determining compliance with the new national and state air quality standards, as well as establishing background levels and measuring pollution transported from areas outside of Delaware.

With the passage of the Clean Air Act in 1970, and the Clean Air Act Amendments in 1990, various control measures implemented by the federal and state governments resulted in major improvements in air quality, particularly regarding major industrial sources. Pollutants of concern today come from a variety of sources including mobile (both on road and off-road vehicles) sources, large industrial facilities, and smaller industries and business. Delaware continues to use its ambient monitoring network to track changes in air quality across the state and evaluate compliance with ambient air quality standards.

History of monitoring network – by decade (X indicates monitor was operating for at least 1 year during that decade); shaded sites are stations not currently operating.

Table 3: Monitoring Network History

County	AIRS (AQS) Site No.	Name/Location	1960s	1970s	1980s	1990s	2000s	2010s
Kent	10-001-0001	Dover		X	X	X		
	10-001-0002	Killens Pond St. Pk.				X	X	X
	10-001-0003	Dover $PM_{2.5}$ behind DE Fed. Credit Union					X	X
	10-001-1001	Bombay Hook	X	X				
New Castle	10-003-0001	Claymont Fire Station	X					
	10-003-0002	UD Farm		X	X			
	10-003-0003	501 Ogletown Rd (Hudson Bldg)			X			
	10-003-0004	Ferris School		X				
	10-003-0005	Old SPCA		X				
	10-003-0006	Gov. Bacon, Delaware City		X	X	X		
	10-003-0007	Mt. Pleasant Farm		X				
	10-003-0010	NCC Engineering Bldg		X	X			
	10-003-0011	Lombardy School		X				
	10-003-0012	St. Georges		X				
	10-003-0018	Lums Pond			X			
	10-003-0069	McKean High School		X				
	10-003-0070	Summit		X	X			
	10-003-1001	UD Farm		X				
	10-003-1002	Naamans Rd	X					
	10-003-1003	River Rd. Park, Bellefonte		X	X	X	X	X
	10-003-1004	Marine Terminal		X	X			
	10-003-1005	Pennsylvania Ave			X			
	10-003-1006	3rd & Union St. Fire Station			X	X		
	10-003-1007	Lums 2, Lums Pond Park				X	X	X
	10-003-1008	Route 9 #1				X	X	X
	10-003-1009	Elsmere				X		
	10-003-1010	Brandywine Creek St Pk (BCSP)				X	X	X
	10-003-1011	UD - Newark $PM_{2.5}$					X	
	10-003-1012	Newark $PM_{2.5}$					X	X
	10-003-1013	Bellevue State Park (Bellefonte2)					X	X
	10-003-1069	Millcreek Rd		X				
	10-003-2001	Ommelanden		X	X			
	10-003-2002	Wilmington, 12th & King	X	X	X	X		
	10-003-2003	Walnut & Taylor St.		X				
	10-003-2004	MLK, MLK Blvd and Justison St.					X	X
	10-003-3001	Claymont, Women's Correctional Center		X	X	X		
	10-003-4001	1000 King St	X	X				
Sussex	10-005-0001	Milford		X				
	10-005-1001	Seaford Water Tower		X	X			
	10-005-1002	Seaford, Virginia Ave.				X	X	X
	10-005-2001	Millsboro DP&L			X			
	10-005-1003	Lewes				X	X	X
		Totals:	5	23	16	13	12	11

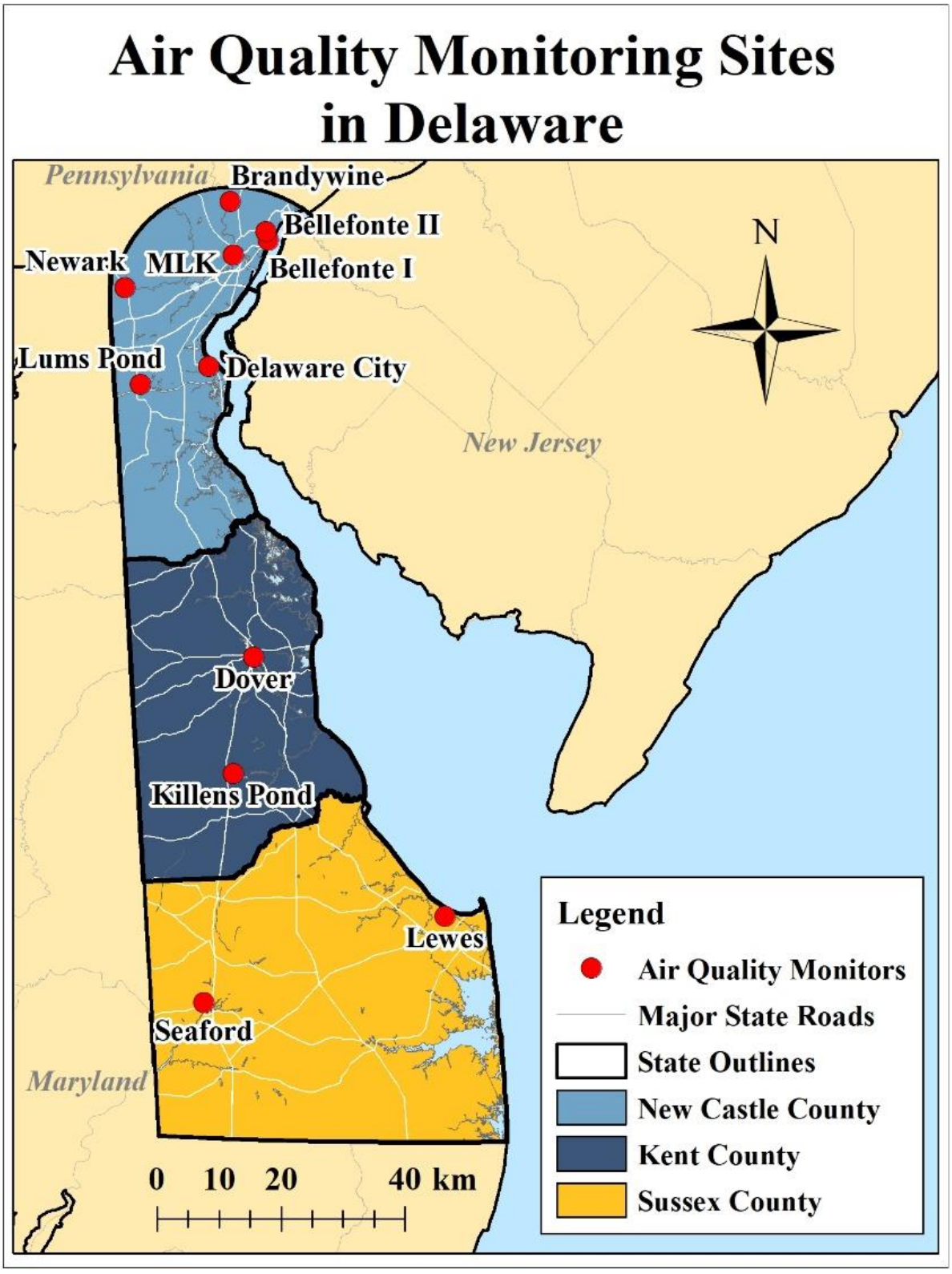
The largest number of monitoring sites existed during the 1970s, with particulate matter and sulfur oxides being the most common pollutants monitored. The largest number of sites has always been located within New Castle County, which has the largest population combined with the largest number of pollution sources. As the network shifted towards more automated monitoring methods and data collection systems in the later 1970s and early 1980s, the size of the monitoring network began to shrink to accommodate long-term or permanent monitoring stations, and greater technical skills required for monitoring operations and management required more focused staff resources.

Locations of monitors continued to evolve to match population growth and pollution source changes. Other issues impacting monitoring locations included changes in land use/ownership and changes in available funding for station upkeep and improvements.

As air quality continued to improve, monitoring focus shifted away from TSP/PM_{10}, SO_2, and CO towards the pollutants that remained above the NAAQS, particularly O_3, and pollutant precursors. More advanced monitoring methods, emissions inventories, control strategy development and more sophisticated computer modeling tools were important in the redirection of monitoring sites throughout this time period. Population changes also played a role in the development of the monitoring network; while New Castle County continued to have the highest population density, significant growth was occurring in Sussex and Kent counties.

Throughout the 1990s and into the new century, restrictions on available resources (both staffing and technological) required consolidation of the network to focus on pollutants of concern in maximum impacted populated areas. A significant new addition to the monitoring network in the late 1990s was the introduction of $PM_{2.5}$ monitors in response to the new $PM_{2.5}$ NAAQS. Through careful rebalancing of resources, including elimination of non-essential monitors, Delaware was able to establish and maintain a statewide $PM_{2.5}$ network in full compliance with all EPA requirements without any additional staffing. Specific information on current status and challenges are covered in the remaining document. More tables on historical monitoring parameters and locations are included in Appendix I.

Figure 1: Delaware Air Monitoring Network Map



Population Summary

Although New Castle County is the most densely populated county, the population is growing much more slowly than in the other areas of the state. The greatest growth is occurring in the southern and western portions of New Castle County which continues to have the greatest total population in Delaware. New Castle is also the most industrialized county with the highest number of air pollution sources as well as traffic density.

Kent County is the "middle" county in Delaware. While Kent has the lowest population density, it also has demonstrated significant population growth since 2000. There is one metropolitan statistical area in Kent County – Dover, which is the centrally located capital city.

Sussex County is the southernmost county in Delaware. Largely because of the resort area along the coast, it has a higher population density than Kent County which is significantly increased in the summer months. The coastal area continues to be the most rapidly growing portion of the county.

The state has experienced significant population growth in recent years in each county as shown in the following table. Estimates for 2019 in Sussex County indicate an estimated 18.8% change from 2010.

Table 4: Population Summary

County	Total Population: 2000 Census	Total Population: 2010 Census	Percent Change in Population 2000 - 2010	Population Estimate July 1, 2019	Percent Change in Estimated Population 2010 - 2019
New Castle	500,265	538,479	7.6%	558,753	3.8%
Kent	126,702	162,310	28.1%	180,786	11.4%
Sussex	156,628	197,145	25.9%	234,225	18.8%
Total	783,600	897,934	14.6%	973,764	8.4%

Figure 2: US Census, Delaware Population Profile

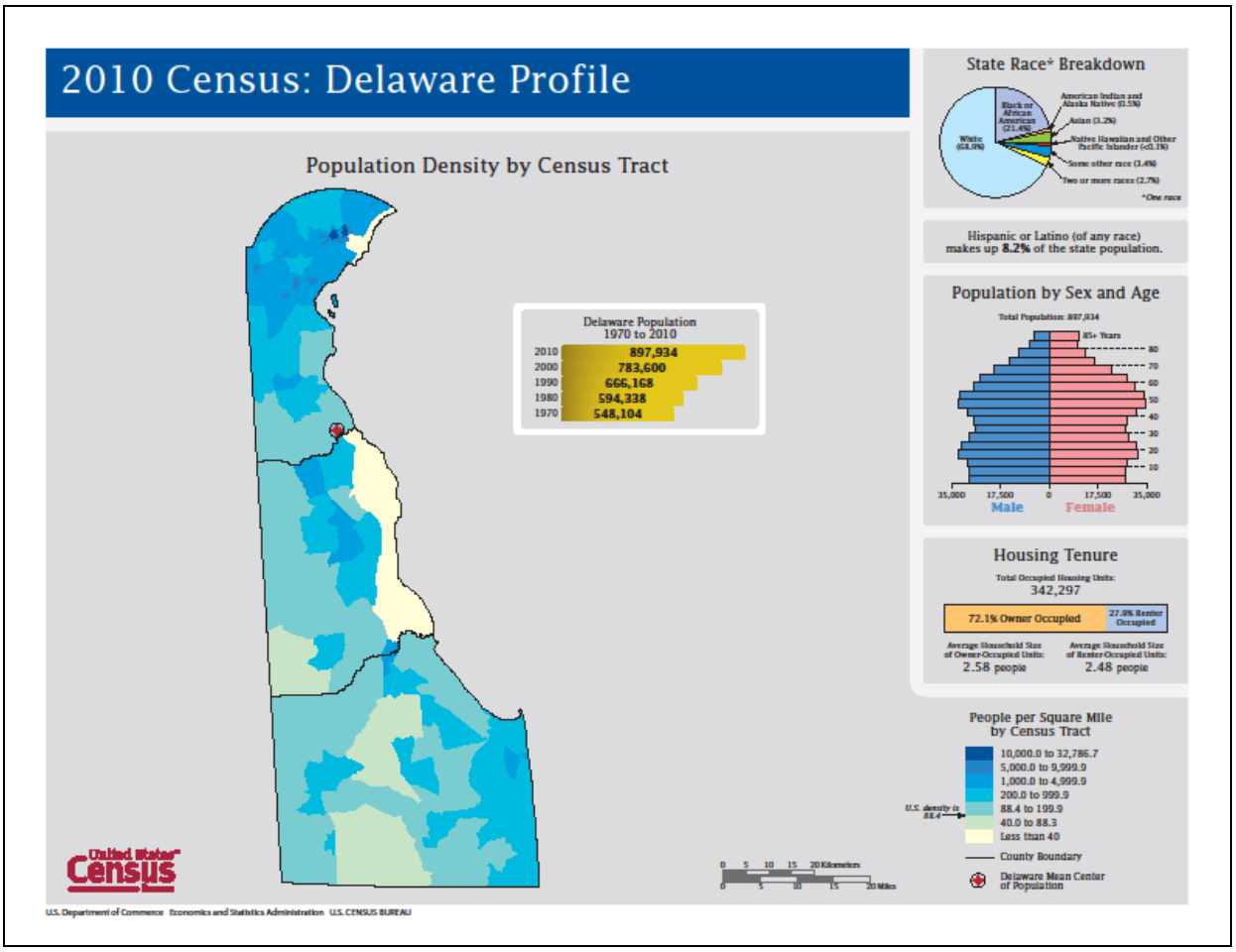


Table 5: CSAs and MSAs for Delaware

CBSA Code	Metro Division Code	CBSA Title	Level of CBSA	Status, 1=metro 2=micro	Metropolitan Division Title	CSA Title	Component Name
20100		Dover, DE	Metropolitan Statistical Area	1			Kent County
37980	48864	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	Metropolitan Statistical Area	1	Wilmington, DE-MD-NJ	Philadelphia-Camden-Vineland, PA-NJ-DE-MD	New Castle County
41540		Salisbury, MD-DE	Metropolitan Statistical Area	1		Salisbury	Sussex County

Meteorological summary

Monthly Climate Normals

Following are climate data summaries for NOAA weather stations in each county. The data are retrieved from the NOAA website http://www.ncdc.noaa.gov/cdo-web/datatools.

Table 6: Monthly Climate Normals by County

NEW CASTLE AIRPORT, DELAWARE: NCDC 1981-2010 Monthly Normals

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max. Temperature (F)	40.2	43.5	52.4	63.5	73.0	81.8	86.1	84.2	77.4	66.2	55.7	44.6	64.05
Mean Temperature (F)	32.4	35.1	43.0	53.3	62.8	72.2	76.8	75.2	67.8	56.2	46.6	36.7	54.84
Mean Min. Temperature (F)	24.6	26.8	33.6	43.0	52.6	62.6	67.6	66.1	58.2	46.1	37.4	28.7	45.61
Mean Precipitation (in.)	3.01	2.68	3.92	3.50	3.95	3.88	4.57	3.25	4.32	3.42	3.10	3.48	43.08

DOVER, DELAWARE: NCDC 1981-2010 Monthly Normals

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max. Temperature (F)	43.4	47.0	54.9	65.7	74.7	83.2	87.0	85.2	79.3	68.8	58.5	47.4	66.26
Mean Temperature (F)	35.2	38.0	45.2	55.0	64.2	73.3	77.7	76.1	69.7	68.8	49.2	39.2	57.63
Mean Min. Temperature (F)	27.1	29.0	35.6	44.3	53.8	63.4	68.4	67.0	60.1	48.7	39.8	31.0	47.35
Mean Precipitation (in.)	3.41	3.07	4.31	3.88	4.25	4.00	4.09	4.36	4.13	3.42	3.48	3.65	46.05

GEORGETOWN COASTAL AIRPORT, DELAWARE: NCDC 1981-2010 Monthly Normals

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Max. Temperature (F)	43.5	46.7	54.4	64.4	73.5	82.5	86.3	84.8	78.1	68.2	58.4	48.1	65.7
Mean Temperature (F)	35.0	37.5	44.7	54.0	63.1	72.5	76.9	75.6	68.5	57.8	48.5	39.2	56.1
Mean Min. Temperature (F)	26.6	28.3	34.9	43.6	52.7	62.6	67.4	66.4	58.9	47.3	38.5	30.4	46.5
Mean Precipitation (in.)	2.92	2.79	4.05	3.63	3.55	4.61	4.19	3.53	4.13	3.72	3.36	3.29	43.77

Wind Roses

Following are wind roses for Airports in each county, using data obtained from the NOAA Local Climate Data database. https://www.ncdc.noaa.gov/cdo-web/datatools/lcd

The “paddles” of the roses indicate direction the wind is blowing from, the length indicates how frequently. The segments indicate the proportion of wind speeds observed in that direction.

Hourly observation data was retrieved spanning 2015 to 2019 from airports located in each county:

- New Castle County: Wilmington New Castle County Airport
  - Station ID: WBAN13781
- Kent County: Dover Airforce Base
  - Station ID: WBAN13707
- Sussex County: Georgetown Delaware Coastal Airport
  - Station ID: WBAN13764

Wind roses with a finer scale of 36 directions are presented below for each county from 2015-2019 as well as 2019 data only.

Figure 3: Wind Roses by County 2015-2019
36 Wind Directions, Source: NOAA LCD Data for airports in each county

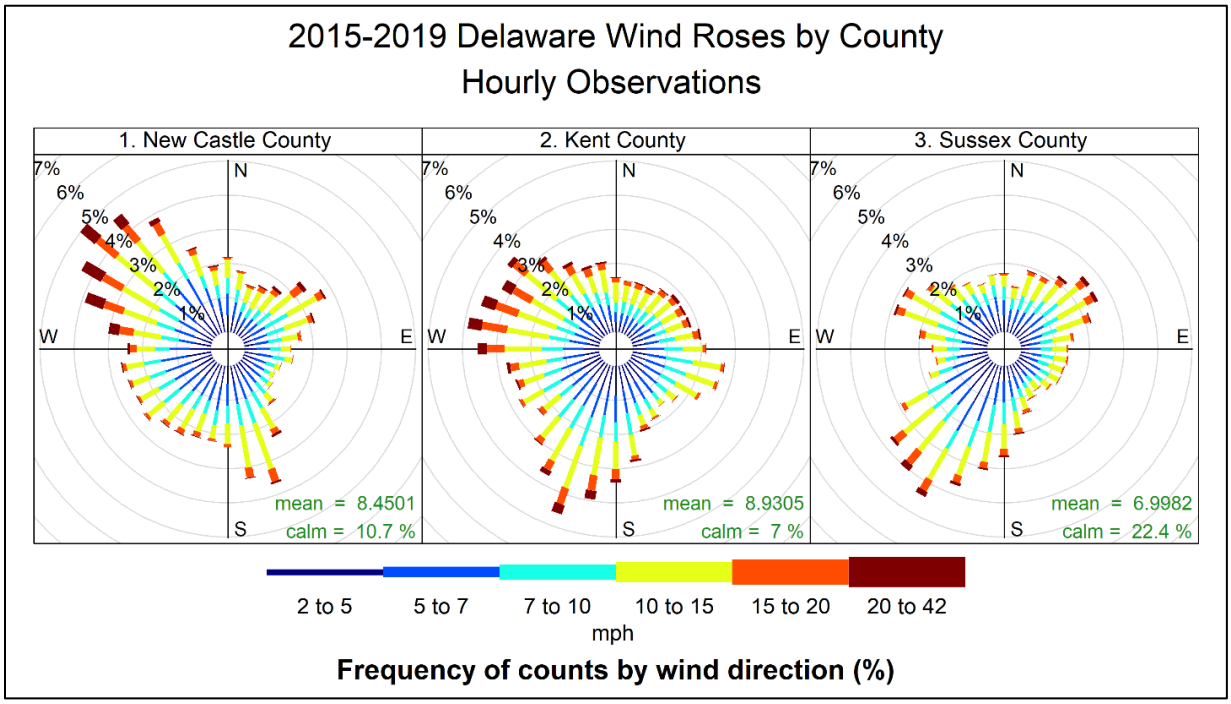
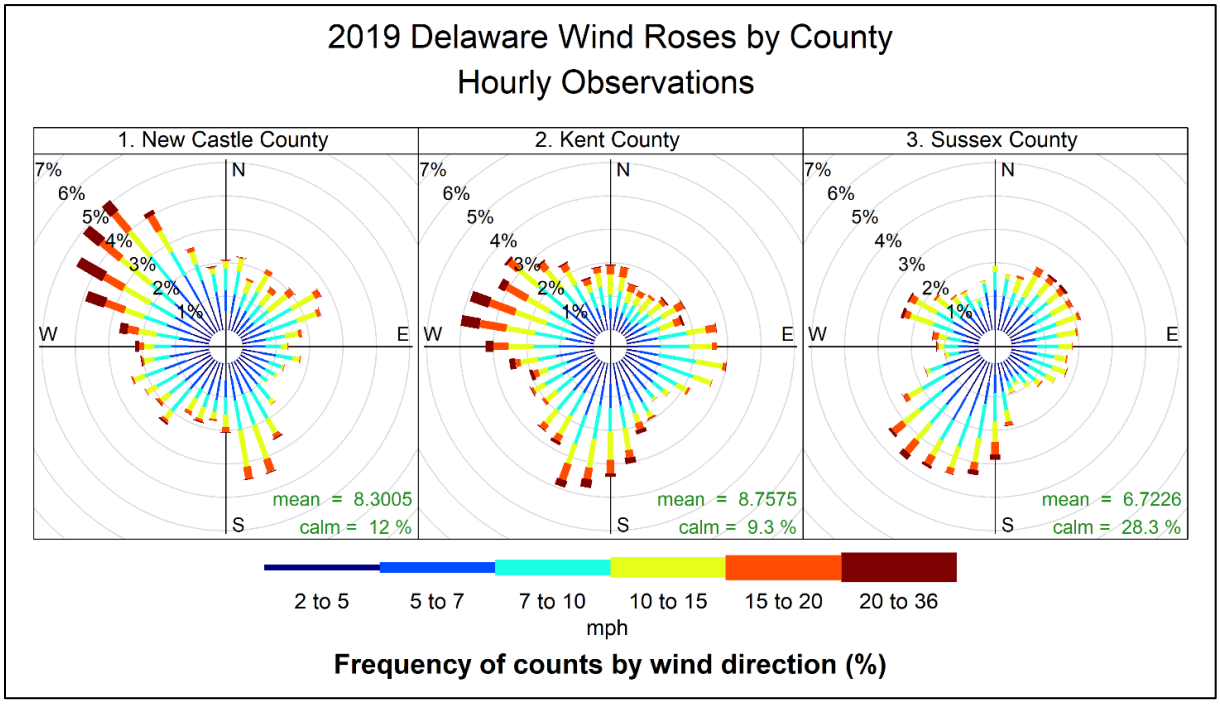


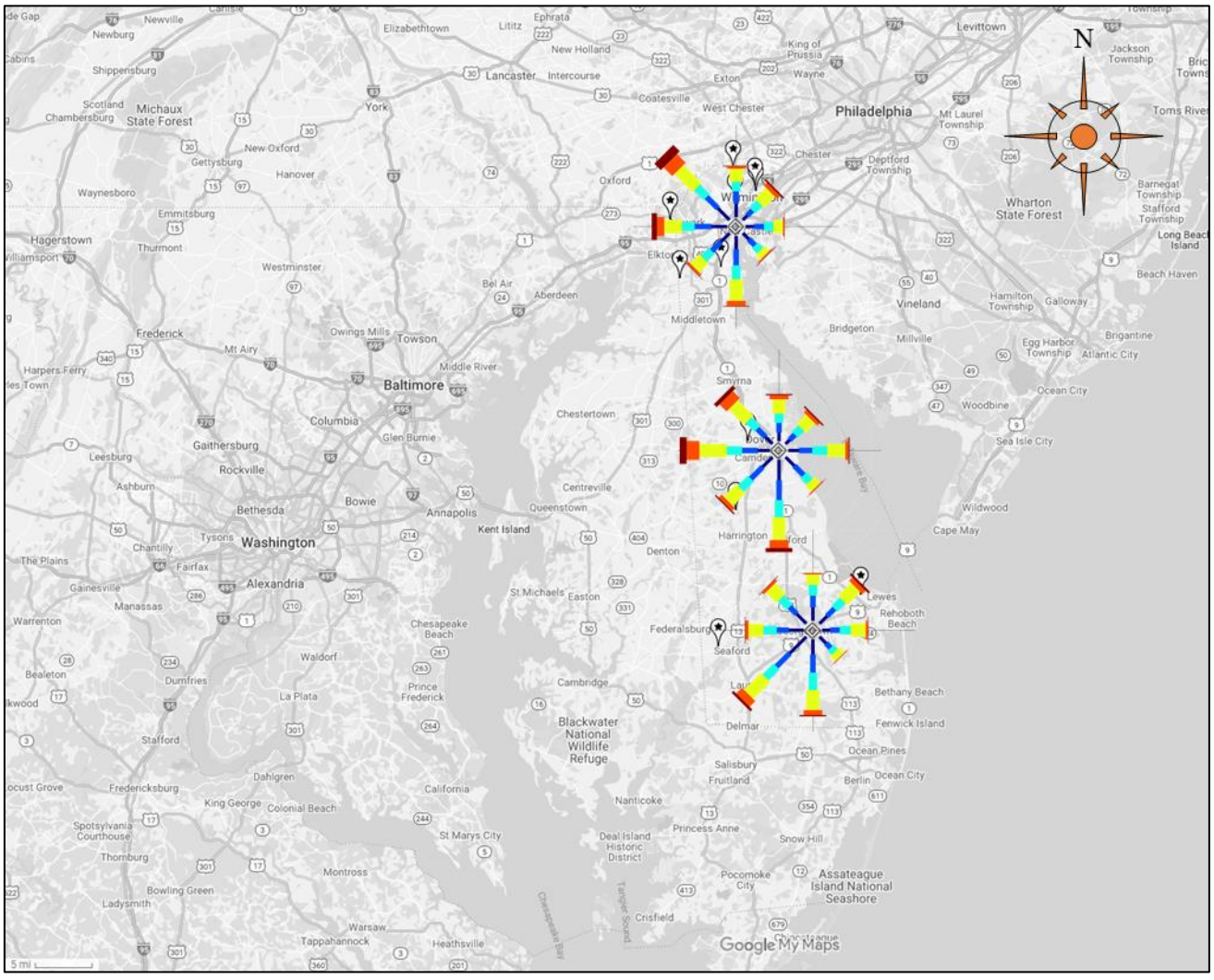
Figure 4: Wind Roses by County 2019 only
36 Wind Directions, Source: NOAA LCD Data for airports in each county



Wind patterns averaged to 8 directions for each county using data from 2015-2019 illustrate general wind patterns across the state. The patterns frequently include westerly and southerly components; however, easterly wind patterns are not uncommon, particularly in Kent County.

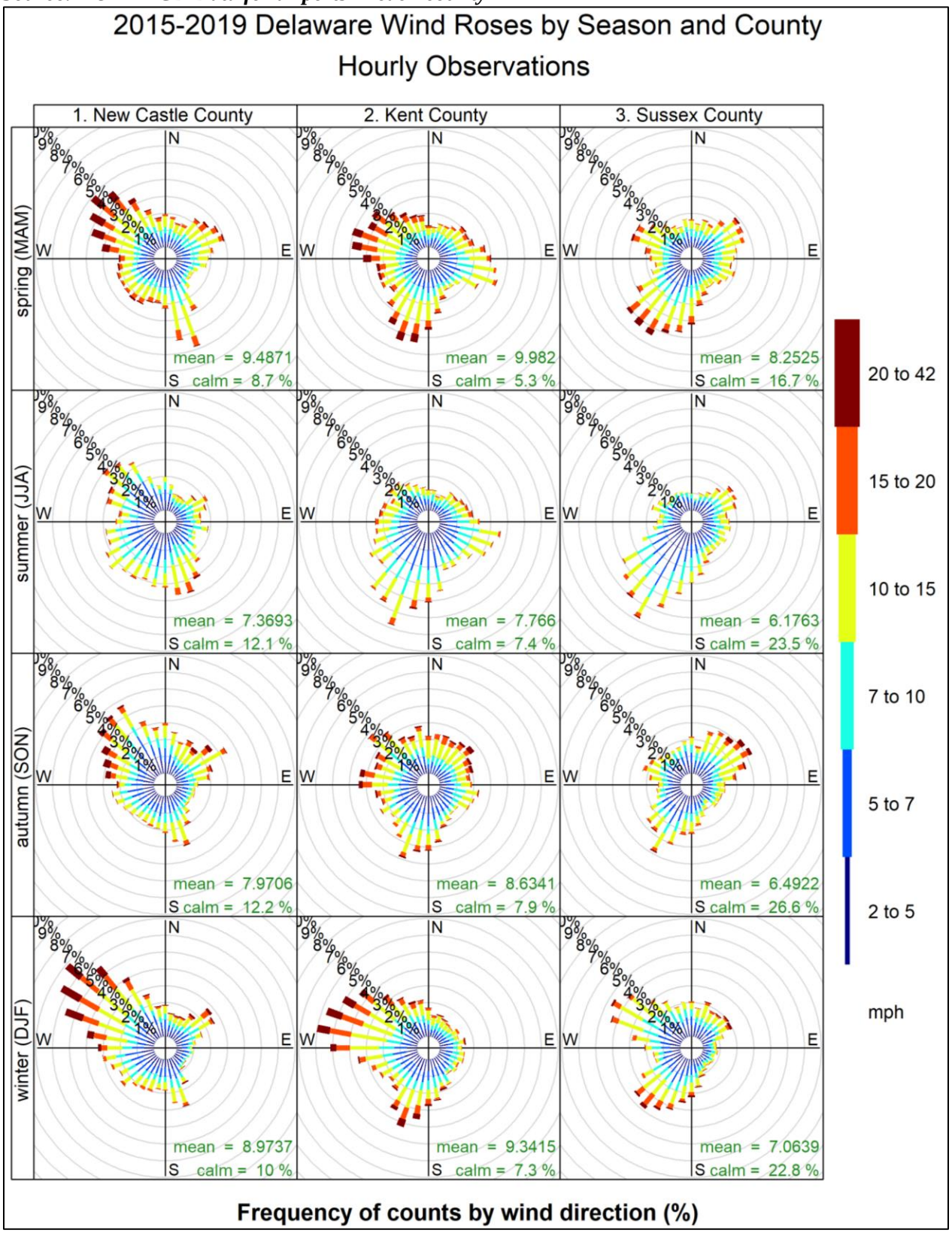
This puts the state generally downwind of the Baltimore/Washington area. The state is generally upwind of Philadelphia/southern New Jersey, although this relationship reverses from time to time. New Castle County is predominantly impacted by winds from Central/Western Pennsylvania.

Figure 5: 2015-2019 County Wind Roses Map Overlay
Source: NOAA LCD Data for airports in each county, and Google Maps
Wind directions averaged to 8 cardinal directions, white pins represent Delaware Monitoring Sites



There is some seasonal variation with west/north westerly winds more dominant in the winter. In the summer south and south westerly more dominant and wind speeds are lower. Wind roses for each county by season included on the following page.

Figure 6: Wind Roses by County and Season 2015-2019
Source: NOAA LCD Data for airports in each county



Monitoring network general issues

Delaware's Annual Monitoring Network Description includes one-page summaries for each monitoring site that contain information on specific parameters (such as latitude/longitude and photographs) that are not discussed in detail in this document. Those summary pages are included in Appendix II.

Data Users: Primary data users are mainly professional staff within the Division of Air Quality. Other major users include EPA and university researchers; the University of Delaware and Delaware State University are frequent users of data and have occasionally collocated projects with monitoring sites. The general public most frequently uses the data as part of the Air Quality Index, either through local news media, from the Air Quality Monitoring website, or through the EPA AirNow website.

Other data users can include independent researchers, including public health researchers, other federal agencies besides EPA, and other local government agencies. The Delaware Division of Air Quality may not be aware of all data users since the data are publicly available from the EPA Air Quality System (AQS) database and users do not need to request the data directly from the Section.

Objectives: The most important monitoring objectives for the networks include NAAQS compliance, population exposure, and long-term trends tracking. These objectives have been part of the network design throughout the history of the monitoring program. More recent objectives include evaluation of emission control strategies and contribution to SIPs or maintenance plans. The AQI is also a required objective that continues to be met.

Special studies, including atmospheric pollutant research and/or model validation, are not generally dominant but are considered on a case by case basis. Local community concerns are considered whenever monitoring network changes are needed and play a role in special study design and reporting.

Domain of Responsibility: The Delaware Division of Air Quality is responsible for monitoring air quality throughout the state. Adjoining upwind and downwind areas maintain their own ambient monitoring networks and data is shared through the AQS system. As mentioned in the meteorological section, the Baltimore/Washington area is generally upwind of Delaware while Philadelphia/southern & central New Jersey are generally downwind.

Table 7: State of Delaware Air Quality Standards

State Requirements: Delaware maintains its own State Air Quality Standards as follows:

Pollutant	Primary Standards Level	Primary Standards Averaging Time	Secondary Standards Level	Secondary Standards Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3) 35 ppm (40 mg/m^3)	8-hour(1) 1-hour(1)	None	
Lead (Pb)	0.15 µg/m^3	3-month Average	Same as Primary	
Nitrogen Dioxide (NO_2)	100 ppb 53 ppb	1-hour(8) Annual (Arithmetic Mean)	None Same as Primary	
Suspended Particulates (TSP)	75 µg/m^3 260 µg/m^3	Annual (Geometric Mean) 24-hour(1)	60 µg/m^3 150 µg/m^3	Annual (Geometric Mean) 24-hour
Particulate Matter (PM_{10})	150 µg/m^3	24-hour(2)	Same as Primary	
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3 35 µg/m^3	Annual(3) (Arithmetic Mean) 24-hour(4)	15.0 µg/m^3 annual mean, averaged over 3 years Same as Primary	
Ozone (O_3)	0.075 ppm 0.12 ppm	8-hour(6) 1-hour(7) (Applies only in New Castle and Kent counties)	Same as Primary Same as Primary	
Sulfur Dioxide (SO_2)	75 ppb 0.03 ppm 0.14 ppm	1-hour(9) Annual (Arithmetic Mean) 24-hour(1)	0.5 ppm (1300 µg/m^3)	3-hour(1)
Hydrogen Sulfide (H_2S)	0.06 ppm 0.03 ppm	3-minute 1-hour	None	

(1) Not to be exceeded more than once per year.
(2) Not to be exceeded more than once per year on average over 3 years.
(3) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations must not exceed 12.0 µg/m3.
(4) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).
(6)(a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.
(b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.
(7)(a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.
(b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.
(8) To attain this standard, the 3-year average of the 98th percentile of 1-hour daily maximum concentrations must not exceed 100 ppb.
(9) To attain this standard, the 3-year average of the 99th percentile of 1-hour daily maximum concentrations must not exceed 75 ppb.

Delaware also maintains an Ozone Action Day program that includes statewide open burning restrictions in effect throughout Delaware from May 1-Sept. 30. Ozone Action Day notices are issued via the state website and local news media in conjunction with the AQI forecast and federal Enviroflash program. This program involves partners in other agencies and encourages the general public to use public transit and take other actions to limit air pollution releases. More specific information on these programs is available from DAQ's Ozone webpage: dnrec.alpha.delaware.gov/air/quality/ozone/.

Performance Measures Defined in the Network Assessment

In order to determine relative value of individual monitors and monitor sites, a set of criteria or performance measures was developed that could be used to evaluate whether the monitors and sites are meeting all relevant monitoring objectives. These performance measures were grouped into four categories: data criteria, statistical criteria, situational criteria, and future needs and special considerations. Following is the list of performance measures used in the assessment. Not all measures were relevant for all monitors or sites.

Data Criteria:

- **% of NAAQS** – ambient data that indicates air quality is at, near, or above the NAAQS level are of greater value than data indicating air quality are significantly (more than 50%) below the NAAQS.
- **Max concentration** – Ambient data that represents the highest concentration in an area and/or is used as the "design value" to determine progress towards attainment with the NAAQS is of higher value.
- **Longevity** – Sufficient ambient data has been collected at that location to apply trends analysis; longer periods of time are of higher value. Characterized as: long (> 10 years), moderate (5 – 10 years), short (3 – 5 years), or insufficient (less than 3 years).
- **Air Quality Index (AQI)** – Ambient data that are used to generate an AQI or AQI forecast for an area are of value.

Statistical Criteria:

- **Uniqueness** – Air quality data that is not similar to air quality measurements from different areas as shown by statistical analyses (correlation, standard deviation, and average difference) is of high value.
- **Measurement Criticality** – There is a significant difference in the design value for an area as shown by statistical analysis for removal bias if the measurement is terminated at the specified location; this would support a high value for that monitor. Data that is not significantly different is of less value.
- **Trends** – Upward, downward, or stable trend that can be used to evaluate progress towards attainment or evaluate control strategies is of high value.

Situational Criteria:

- **Concentration gradient** – Ambient data at the specified location that are used to determine changes in concentrations between different areas are of high value.
- **Meteorological pattern** – Monitor located in primary downwind location of a source or urban area is of high value.
- **Area Scale** – The monitor is located with the appropriate scale of representation according to federal and local requirements (microscale, middle scale, neighborhood scale, etc.); locations judged not to represent the appropriate scale are of low value.
- **Area Represented** – The monitor represents air quality in an area not otherwise represented; may be only monitor in an area.
- **Multi-pollutant** – Using situational analysis methods, this ambient measurement complements other measurements collected at that location and is of additional value.
- **Federal Requirement** – Ambient monitoring that is specifically required by EPA is of high value.

Future Needs and Special Considerations:

- **Cost** – For monitors classified as Marginal and below, the funding needed to support continued measurements may be considered.
- **Impact from NAAQS Revisions** – New or revised NAAQS may require modifications to the monitoring design of the existing ambient measurement.
- **Source-impact** – Ambient measurement is dominated by impacts from local sources; if pollutant site is designated for source-oriented impacts, this would be of high value.
- **Community Representation** – Ambient data that are being collected to address local concerns is of additional value.

Each monitor was evaluated and ranked as listed below. Each monitoring site was then evaluated in totality for all monitors at that site.

- Critical Sites and Monitors – These sites are of high value and will be continued. Critical sites meet one or more of the following criteria:
    - The site is the design value site for an area that is at or above the NAAQS
    - Design values would be significantly changed if the monitor/site were discontinued (removal bias)
    - Ambient data are close to or above the NAAQS
    - Long-term multi-pollutant site(s) used by multiple data users for trends and model evaluation (i.e., SIP development and tracking)
    - Federally mandated monitor or site (i.e., O_3 transport or $PM_{2.5}$ background)

- Credible Sites and Monitors – These sites are the locations that are expected to continue but may not be the design value location at or above the NAAQS. Credible sites will have one or more of the following criteria:
    - Data provides supplemental information to identify exposures and support AQI forecasting and reporting
    - Data are used for trends, but are below the NAAQS
    - Data are occasionally the highest across the represented area due to seasonal meteorology or unique winds
    - Design values are below the NAAQS but would be significantly changed if the monitor/site were discontinued (removal bias)
    - Site is the design value location but is below the NAAQS.
    - Sites/monitors represent a unique area, population, or condition of concern.

- Marginal Sites and Monitors – These sites and monitors are those locations that may be candidates for removal or movement. Marginal sites are characterized by the following:
    - Data are used for trends, but are far below the NAAQS (< 50% of NAAQS)
    - Not a federally mandated monitor or site
    - Sites that correlate well (i.e., are not unique) with a nearby site(s), but which measure lower levels than the nearby site.

- New Sites and Monitors – These represent potential areas of investment pending movement of monitoring resources from other locations or new resources introduced to our program.
    - Newly required locations from recent NAAQS reviews
    - Additional measurements at critical and credible locations that could provide additional insight to data users

Analysis of current network by pollutant
Ozone (O_3)

Current ozone sites

Ozone is a priority pollutant in Delaware due to the continuing non-attainment status of all three counties in the state. Although concentrations have been declining since monitoring began, the state continues to record unhealthy levels of O_3 throughout the state.

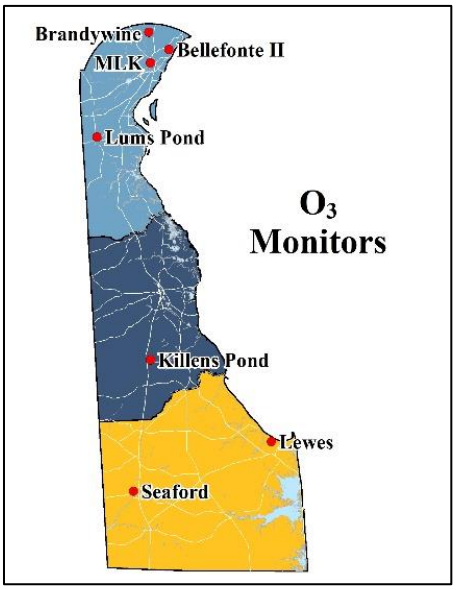


Figure 7: DE O_3 Monitor Map

Monitoring Requirements

Within an O_3 network, at least one O_3 site for each MSA, or CSA if multiple MSAs are involved, must be designed to record the maximum concentration for that metropolitan area. More than one maximum concentration site may be necessary in some areas. Other types of monitoring sites are needed to determine maximum population exposure, background concentrations, and concentrations being transported into an area (boundary conditions). The appropriate spatial scales for O_3 sites are neighborhood, urban, and regional. Since O_3 requires appreciable formation time, the mixing of reactants and products occurs over large volumes of air, and this reduces the importance of monitoring small scale spatial variability.

The prospective maximum concentration monitor site is selected in a direction from the city that is most likely to observe the highest O_3 concentrations, more specifically, downwind during periods of photochemical activity. Since O_3 levels decrease significantly in the colder parts of the year in many areas, O_3 is required to be monitored only during the "ozone season" as designated in the 40 CFR Part 58 Appendix D, which currently in Delaware is March 1 through October 31.

Delaware operates seven O_3 monitoring sites, including sites for maximum downwind concentrations, background concentrations, and transport conditions. As of 2014, all monitors operate year-round. Hourly data is sent to the AirNow website to generate the daily Air Quality Index and to be used in mapping O_3 concentrations throughout the region. The highest number of monitors are located within the northern part of the state, New Castle County, which has the highest population density and longest history of NAAQS violation. There is one monitor in Kent County, which serves as a rural/background site. There are two monitors in Sussex County; one in the Seaford area and one in the coastal resort area (Lewes). In January 2011, the NCore site in Wilmington began officially O_3 monitoring.

Following are the O_3 sites along with the county and associated MSA along with the monitoring objectives. Most sites have multiple objectives, with population exposure the most widespread. It should be noted that the coastal resort areas in Sussex County represent a high seasonal population density that is not reflected in the annual census bureau population statistics.

Table 8: Delaware O_3 Monitoring Sites

Site	County/CSA/MSA	Objectives and Monitor Type
Brandywine Creek (BCSP)	New Castle Phil. CSA	NAAQS compliance Population exposure Secondary downwind from Wilmington (max. conc.) Trends AQI
Bellefonte II	New Castle Phil. CSA	NAAQS compliance Population exposure Primary downwind from Wilmington (max. conc.) Trends AQI
MLK NCore (Wilmington)	New Castle Phil. CSA	NCore requirement NAAQS compliance Population exposure Trends AQI
Lums Pond	New Castle Phil CSA	NAAQS compliance Transport Upwind for Wilmington Trends AQI
Killens Pond	Kent Not in MSA	NAAQS compliance Background Trends AQI
Seaford	Sussex Salisbury CSA	NAAQS compliance Population exposure Trends AQI
Lewes	Sussex Salisbury CSA	NAAQS compliance Population exposure Coastal area Trends AQI

On October 1, 2015, the EPA strengthened the primary and secondary National Ambient Air Quality Standards (NAAQS) for ground-level ozone from the 2008 NAAQS of 0.075 parts per million (ppm) over an 8-hour period to 0.070 ppm. The eight-hour standard is achieved when the annual fourth highest daily eight-hour concentration, averaged over three years, is less than or equal to the standard.

Situational analyses

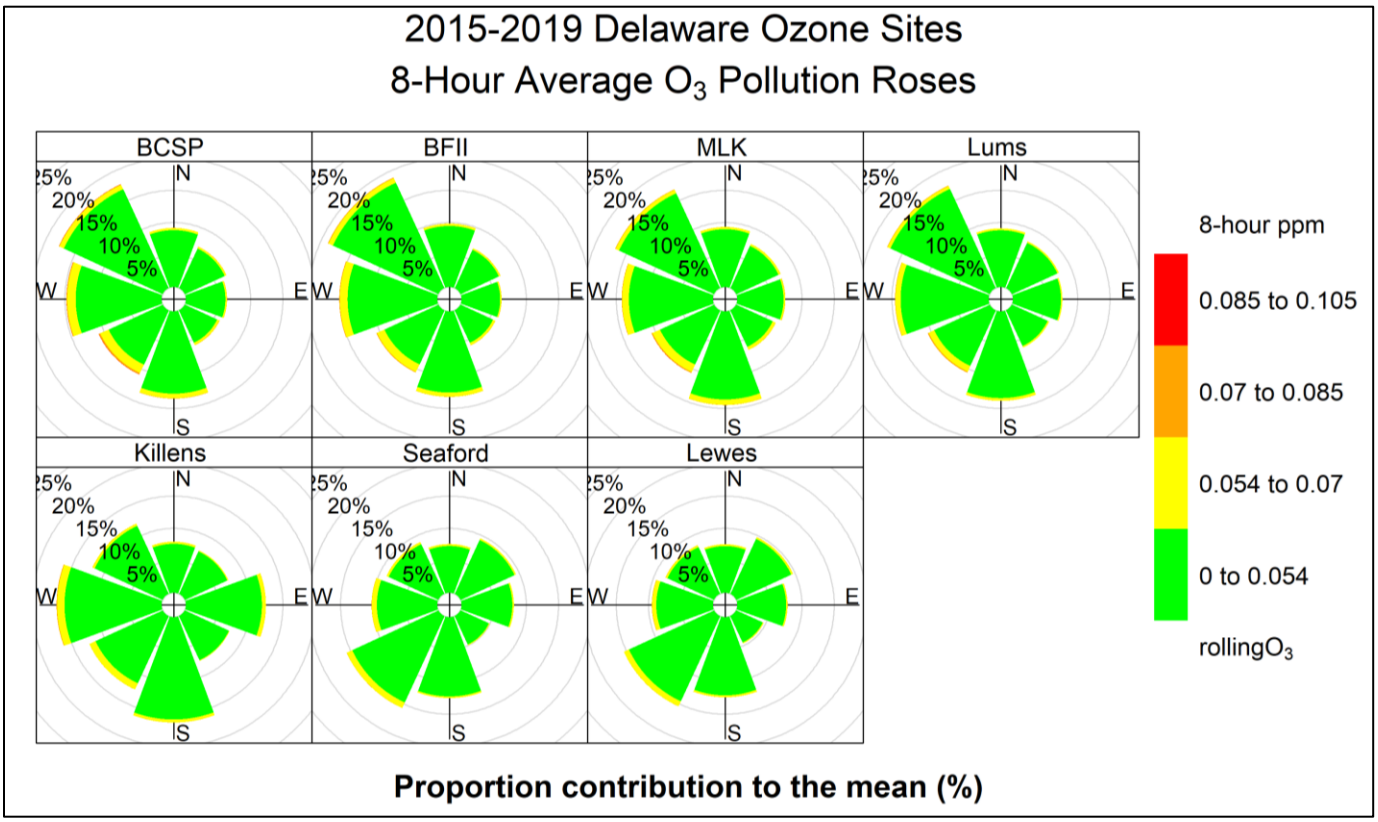
Meteorological data for pollution roses was obtained from the NOAA Local Climatological Database (LCD), unless otherwise noted. https://www.ncdc.noaa.gov/cdo-web/datatools/lcd

Hourly observation data was retrieved for 2019 from airports located in each county:

- New Castle County: Wilmington New Castle County Airport
  - Station ID: WBAN13781
- Kent County: Dover Airforce Base
  - Station ID: WBAN13707
- Sussex County: Georgetown Delaware Coastal Airport
  - Station ID: WBAN13764

EPA Air Quality Index (AQI) colors and breakpoints used for each pollutant. Highest Rolling 8-hour concentrations generally occur with winds from the west.

Figure 8: Pollution Roses for All Ozone Monitoring Sites
2015-2019 Rolling 8-Hour Averages
Wind data source: County Airports, NOAA LCD



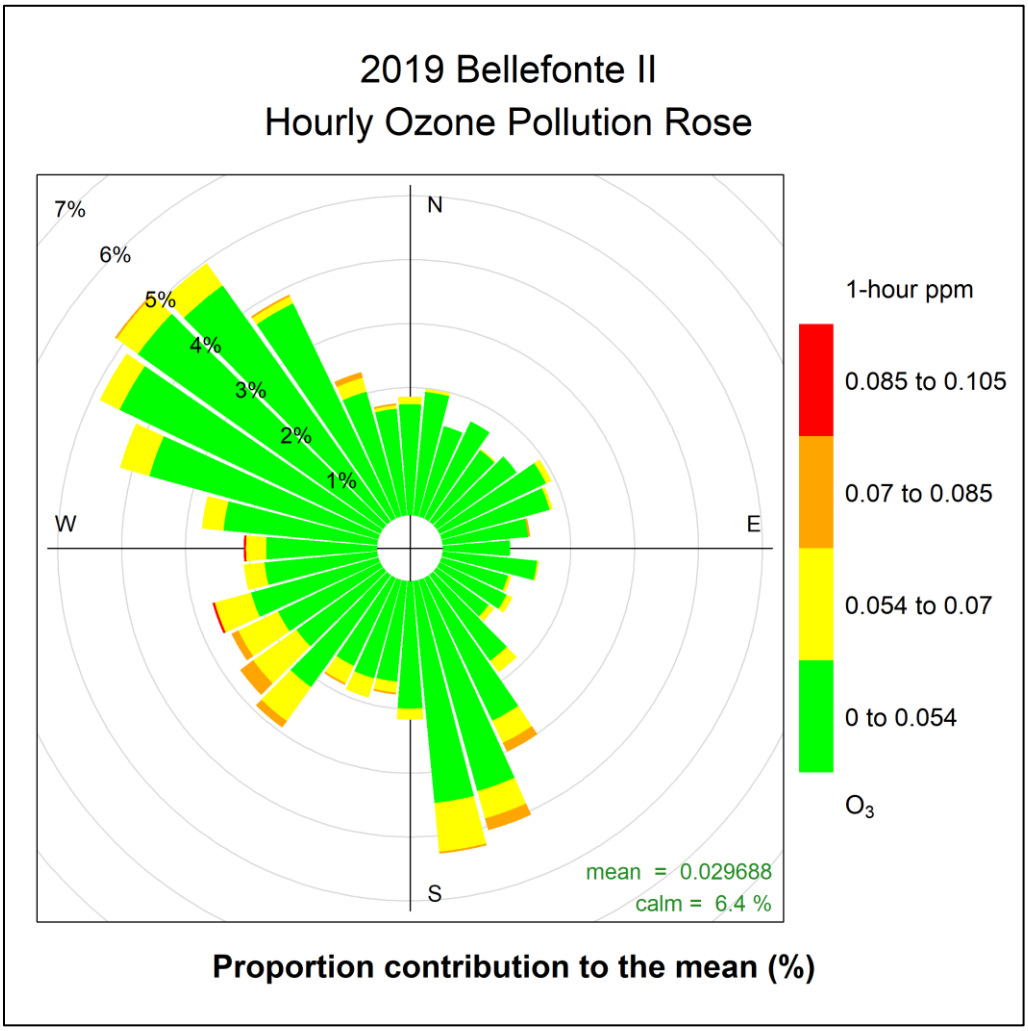
New Castle County sites and characteristics

Bellefonte II (10-003-1013) is the successor site to Bellefonte (I) (10-003-1003) at the New Castle County River Road Park. Bellefonte was originally established in 1969 to monitor O_3 and SO_2. When changing site characteristics began to interfere with O_3 monitoring, a new site (Bellefonte II) was established in 2001 in Bellevue State Park, less than a mile to the north. The Bellefonte II site meets all EPA siting criteria. 2019 data from the Wilmington Airport was used to generate wind direction data for the pollution rose.

Bellefonte II is neighborhood scale for O_3, and monitoring objectives are compliance with the NAAQS, population exposures, and trends. Bellefonte II is in the primary downwind direction from Wilmington, and historically was the maximum downwind concentration site. Although concentrations in recent years appear to have declined, the site still provides information on concentration gradients between Wilmington and the nearby Pennsylvania (Delaware County) and Philadelphia CSA.

Figure 9: O_3 Pollution Rose – Bellefonte II

Wind data source: Wilmington New Castle County Airport, NOAA LCD

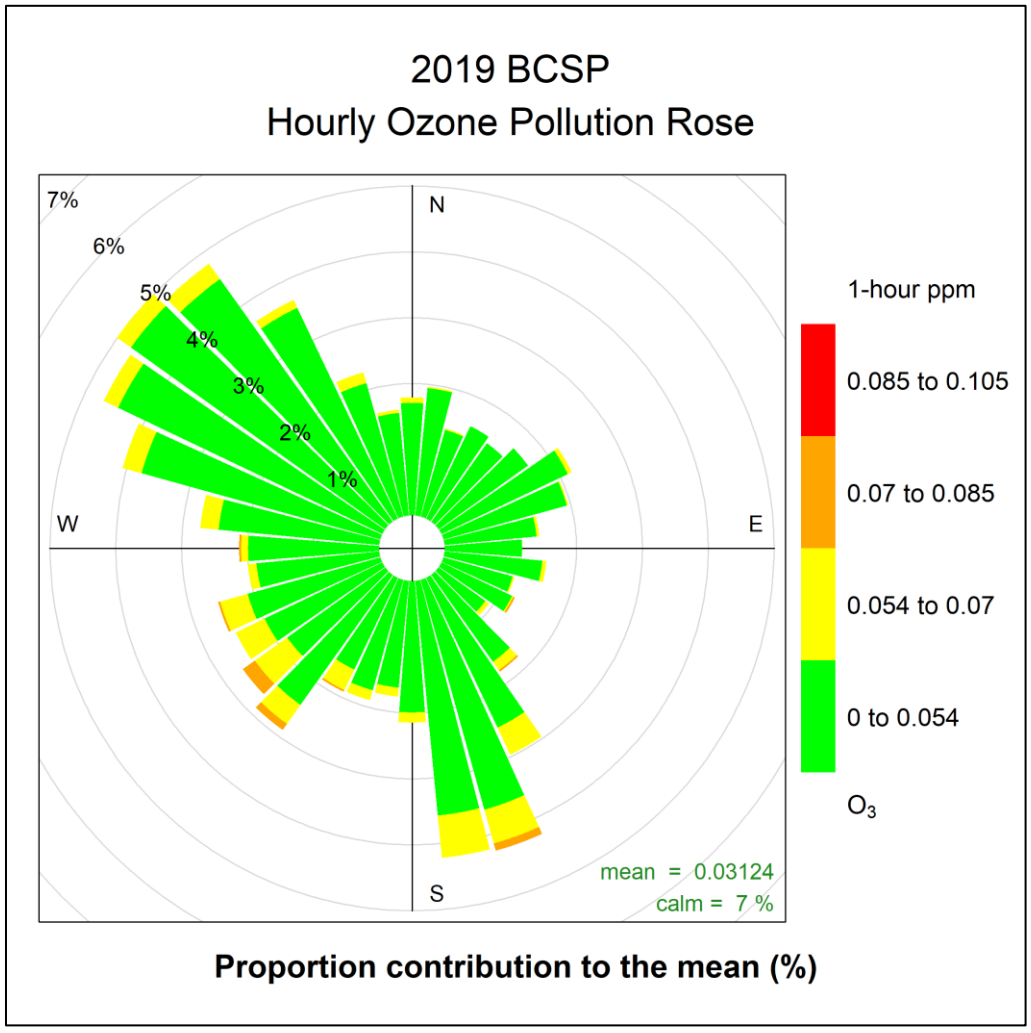


High hourly O_3 concentrations are generally seen with the west/southwest/south wind directions.

Brandywine Creek State Park (BCSP) (10-003-1010). The Brandywine site is located within Brandywine Creek State Park. This is a neighborhood scale site for O_3 monitoring and was established in 1994. The site meets all EPA siting requirements. The Brandywine site is in the secondary downwind direction from Wilmington. The objectives are compliance with the O_3 NAAQS, population exposure, and trends.

This site was established after the Claymont (10-003-3001) site was discontinued. Unlike Claymont, which was in the same downwind direction as Bellefonte from Wilmington, Brandywine was sited to represent O_3 concentrations in a different direction from the urban area of Wilmington. The availability of a site within state park boundaries also allowed a monitoring site close to populated areas but in a rural setting far enough from nearby major roadways to avoid NOx scrubbing of O_3. The location of this site north of Wilmington also allows it to represent regional transport on days with winds from the north/northwest, although this is not the predominant high O_3 condition for New Castle County.

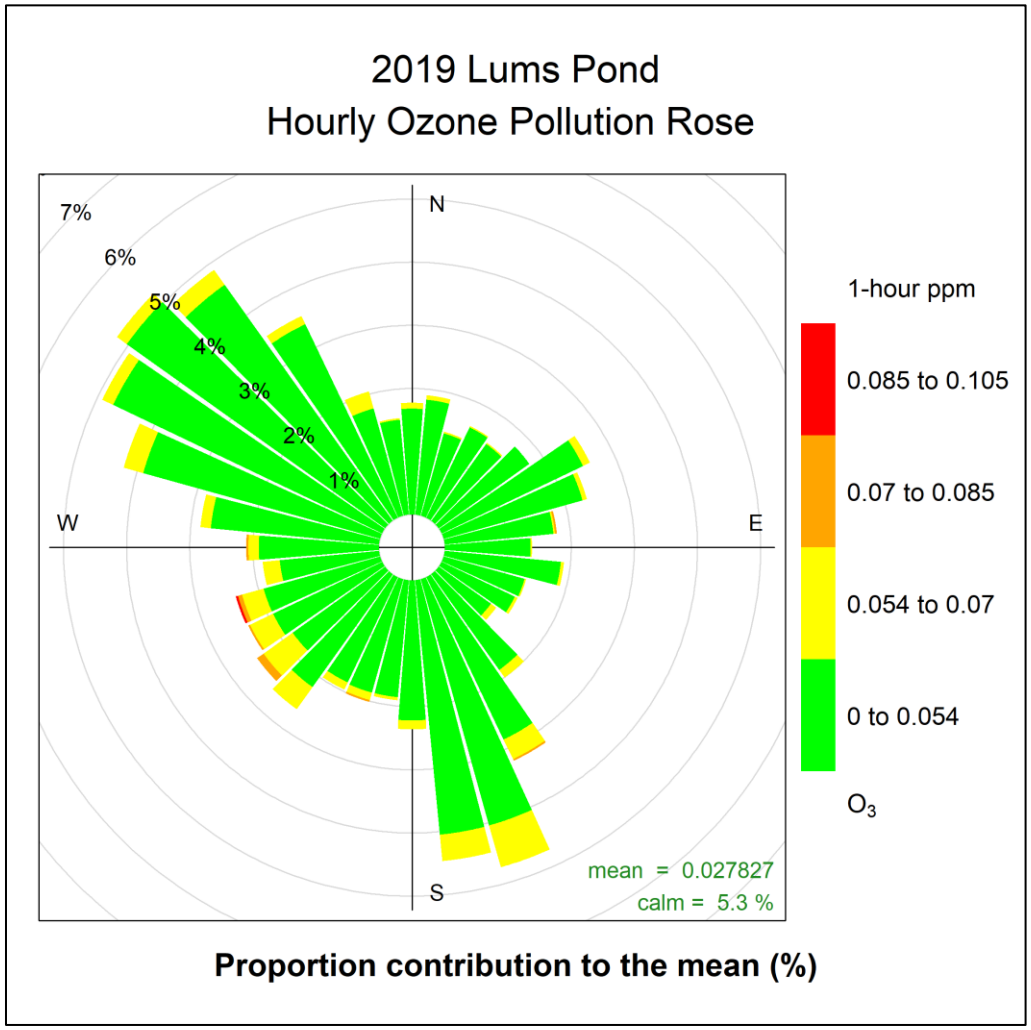
Figure 10: O_3 Pollution Rose – Brandywine Creek State Park (BCSP)
Wind data source: Wilmington New Castle County Airport, NOAA LCD



Highest hourly O_3 concentrations are generally seen with the southwest/south wind directions. Historically, occasional higher concentrations with winds from the north or east have been observed but these are not frequent occurrences.

Lums Pond (10-003-1007). The original Lums Pond O_3 site (10-003-0018) was established in 1981 at Lums Pond State Park. Changes in a nearby park maintenance area caused the site to be moved to a more open area of the park in late 1991, and the new Lums Pond site began reporting data in January 1992. The Lums Pond site is a neighborhood scale site located in a general upwind direction from Wilmington. The site meets all EPA siting criteria. The site objectives are NAAQS compliance, regional transport, population exposure, and trends. This location is representative of transport into Delaware along the general I-95 corridor.

Figure 11: O_3 Pollution Rose – Lums Pond
Wind data source: Wilmington New Castle County Airport, NOAA LCD



High hourly O_3 concentrations are more frequently seen with the southwesterly wind directions. Although southeasterly directions can also see higher hourly contributions.

MLK NCore (Wilmington) (10-003-2004)

National Core Monitoring Strategy – NCore

In October 2006 the United States Environmental Protection Agency (EPA) issued final amendments to the ambient air monitoring regulations for criteria pollutants. These amendments are codified in 40 CFR parts 53 and 58. The purpose of the amendments was to enhance ambient air quality monitoring to better serve current and future air quality needs. One of the most significant changes in the regulations was the requirement to establish National Core (NCore) multi-pollutant monitoring stations. These stations provide data on several pollutants at lower detection limits and replace the National Air Monitoring Station (NAMS) networks that have existed for several years. The NCore sites must measure, at a minimum, $PM_{2.5}$ particle mass using continuous and integrated/filter-based samplers, speciated $PM_{2.5}$, $PM_{10-2.5}$ particle mass, O_3, SO_2, CO, NO/NOy, lead, wind speed, wind direction, relative humidity, and ambient temperature.

Each State is required to operate at least one NCore site. The objective is to locate and help characterize urban- and regional-scale patterns of air pollution. In 2009, EPA provided funding to begin the process of establishing an NCore station in Delaware. After evaluating the existing network, historical data, census data, meteorology, and topography, Delaware's proposal for the existing MLK monitoring site as Delaware's NCore site was accepted by EPA.

Delaware's NCore monitoring, including PMcoarse, O_3, and NOy, became operational on January 1, 2011. In 2016 the shelter was replaced to make room for the required PAMS equipment.

Photochemical Assessment Monitoring System Monitoring Strategy - PAMS

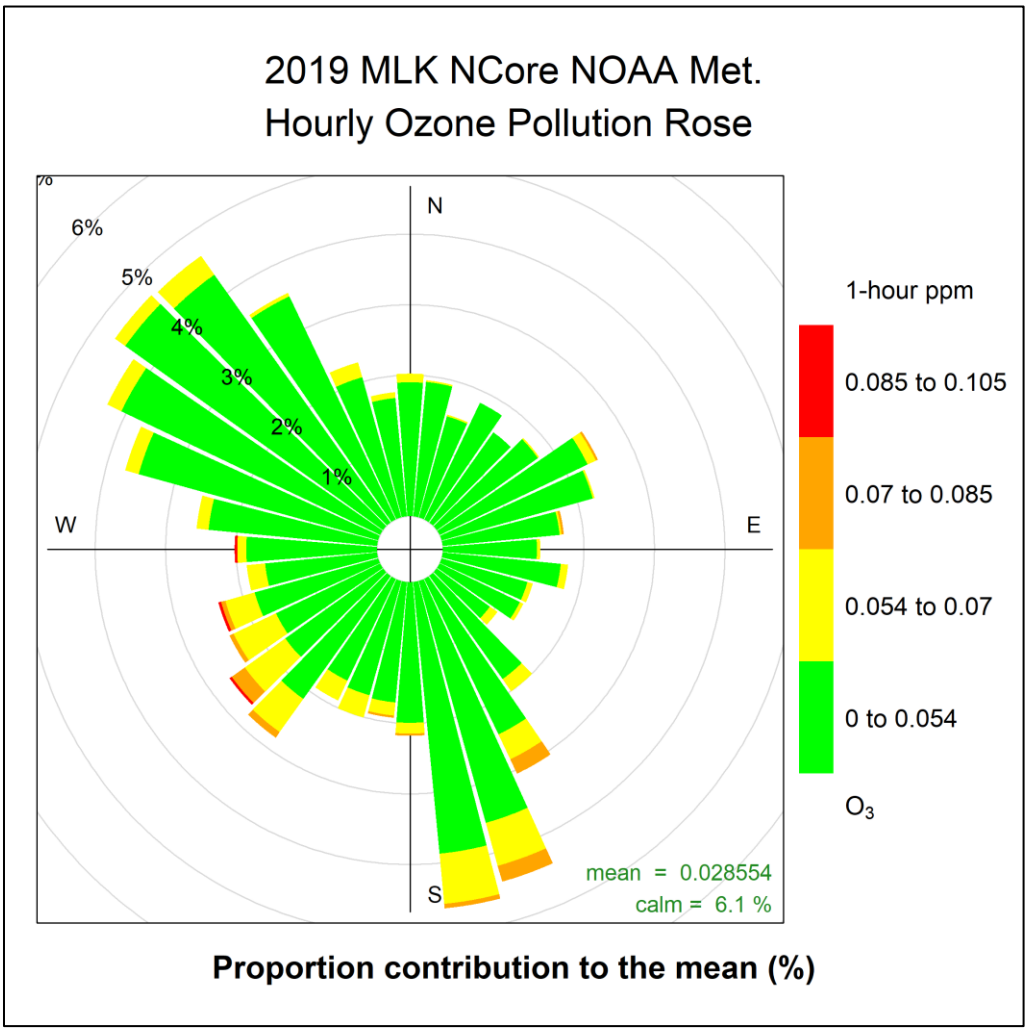
The Clean Air Act (CAA) of 1990, Section 182 (c)(1), required the EPA to promulgate rules for enhanced monitoring of O_3, NOx, and volatile organic compounds (VOCs) for O_3 nonattainment areas based on their classification with the goal of obtaining more comprehensive and representative data on O3 air pollution. PAMS measurements are required minimally during the PAMS (summer) sampling season, which is June 1 through August 31, at all NCore sites in Core-Based Statistical Areas (CBSAs) with a population of 1,000,000 people or more.

As part of the Philadelphia CBSA and OTR Delaware is required to establish a PAMS site at the NCore site in Wilmington. As part of the PAMS network, the following measurements are required:

1. Hourly speciated VOC measurements with auto-GCs
2. Carbonyl sampling (three 8-hour samples on a one-in-three-day sampling frequency)
3. NO, true NO2, and NOy measurements
4. Surface meteorology measurements including mixing height

Based on 40 CFR part 58, Appendix D, state air monitoring agencies are required to begin making PAMS measurements at their NCore location(s) by the amended June 1, 2021 date (Extension granted 12/20/2019). DE DAQ plans to begin making PAMS measurements at the MLK NCore location by June 1, 2021 and will work with EPA to begin measurements on or before the final revised start date for this network.

Figure 12: O_3 Pollution Rose – MLK NCore (Wilmington)
Met Data Source: Wilmington New Castle County Airport, NOAA LCD



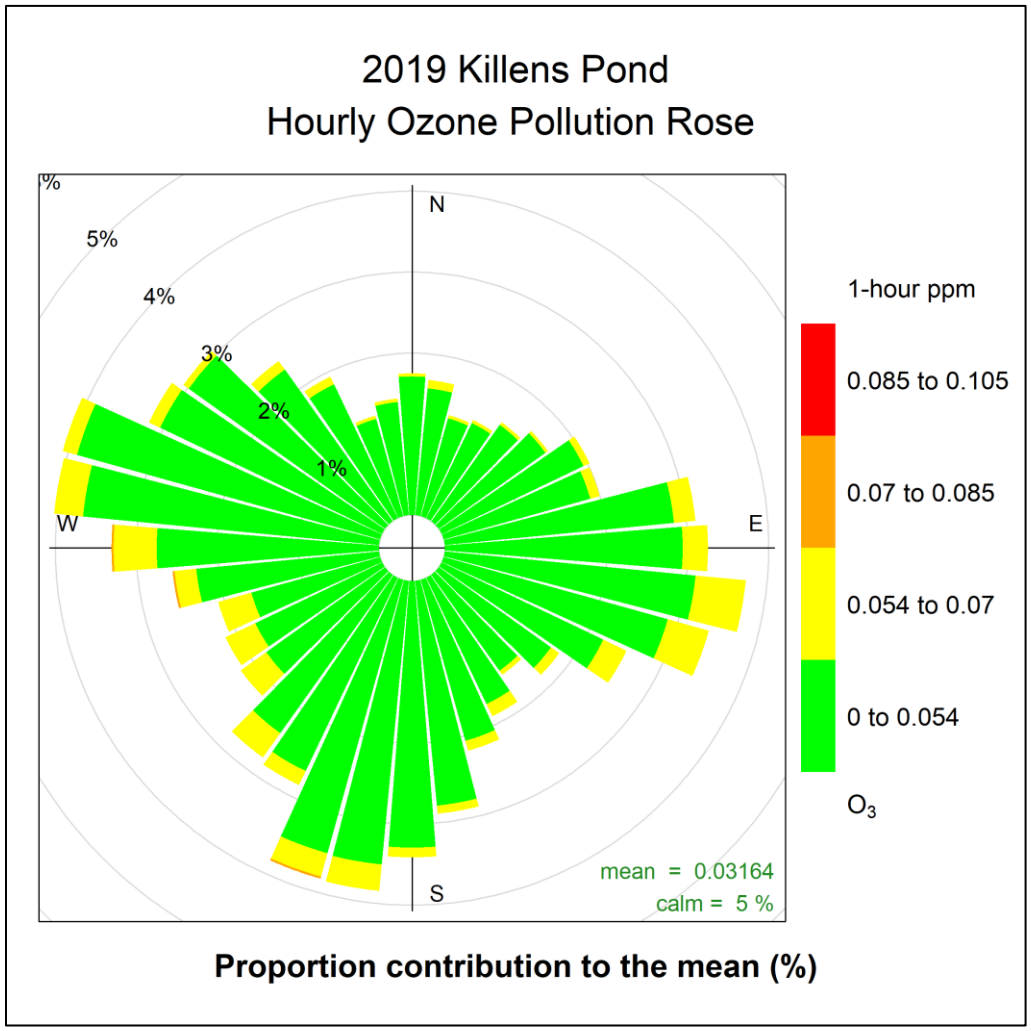
High hourly O_3 concentrations are more frequently seen with the southwest & south/southeast wind directions. The highest hourly concentrations typically occur from the west/southwest.

Kent county sites and characteristics

Killens Pond (10-001-0002). The Killens Pond site was established in 1995 in a rural area south of Dover as a background O_3 site. It is located within Killens Pond State Park. This site is neighborhood scale and meets all EPA siting criteria. The objectives include NAAQS compliance, background concentrations, and trends. Killens Pond is the only O_3 monitoring site in Kent County.

Figure 13: O_3 Pollution Rose – Killens Pond

Wind data source: Dover Airforce Base, NOAA LCD



High hourly O_3 concentrations show less directionality at this site, but there are more frequent instances of elevated O_3 with wind with a westerly component.

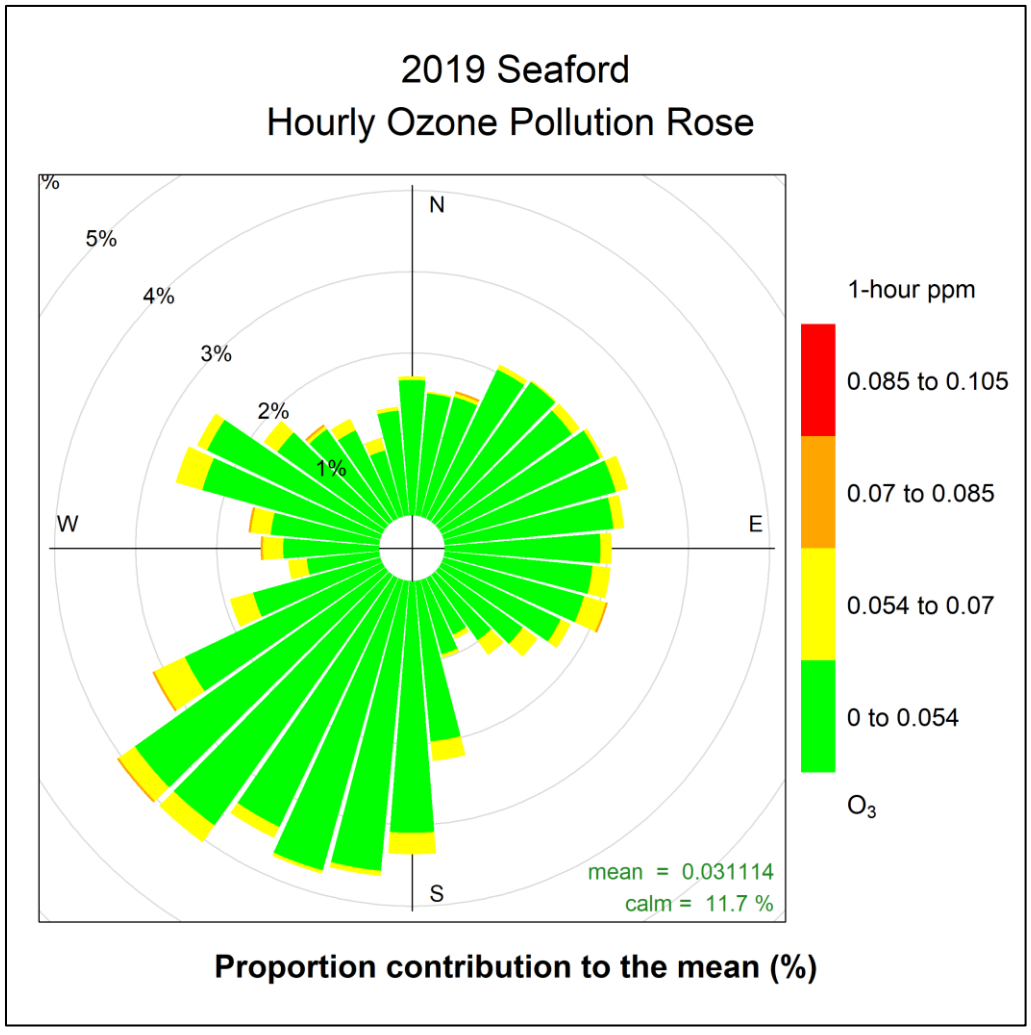
Sussex County sites and characteristics

Seaford (10-005-1002) The original Seaford monitoring site (10-005-1001) was established in 1971 at a location near the Seaford water tower. O_3 monitoring began in 1983. Over time, site maintenance problems developed at the water tower that interfered with O_3 monitoring, and in 1990 it was relocated further north to the current site on Virginia Ave.

The site is neighborhood scale and is suburban. The site is impacted by local point sources, mobile sources, and regional transport. The site meets all EPA siting criteria. The monitoring objectives are NAAQS compliance, population exposure, and trends.

Figure 14: O_3 Pollution Rose - Seaford

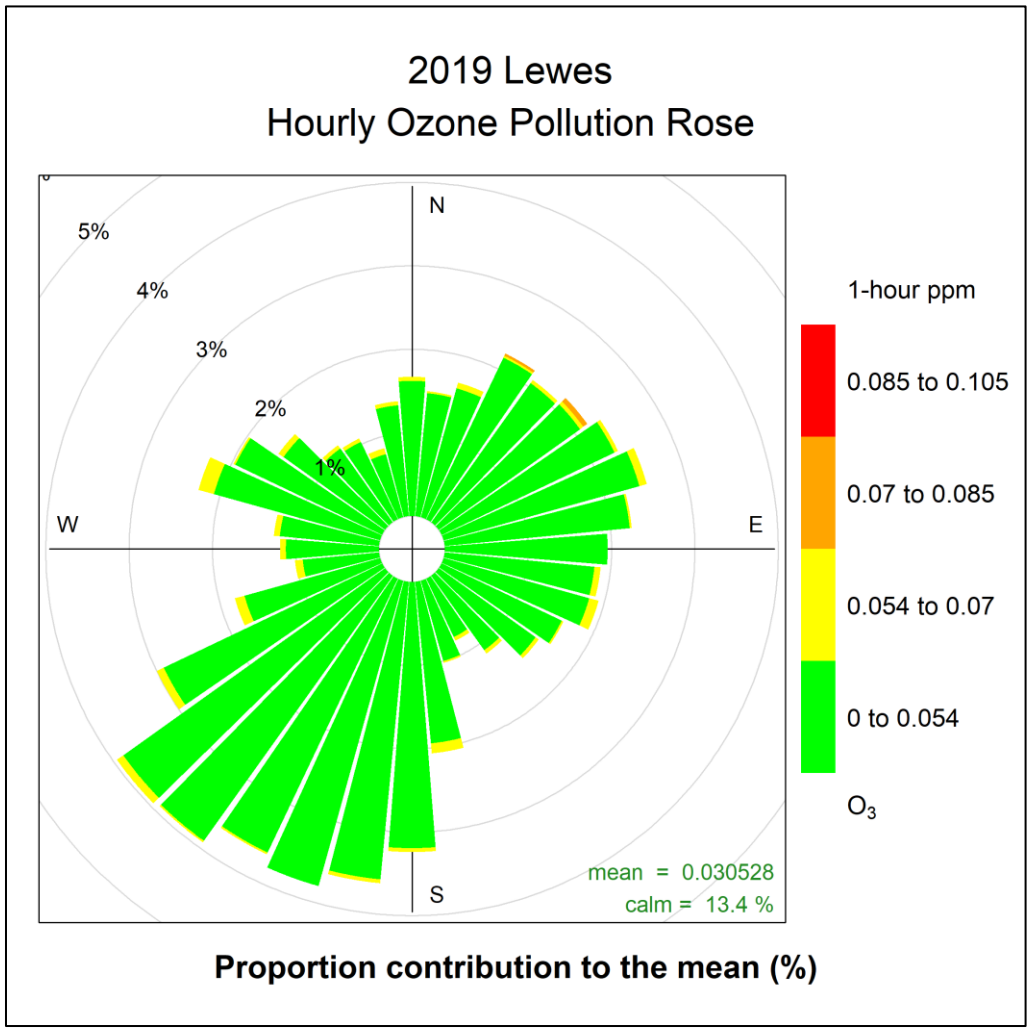
Wind data source: Georgetown Delaware Coastal Airport, NOAA LCD



While elevated hourly O_3 concentrations occur with winds from all directions, highest concentrations are associated with winds with a westerly component.

Lewes (10-005-1003) It had been recognized for some time that the O_3 site in Seaford was not completely representative of the maximum population exposure in the county because of the seasonal population shift in the resort areas along the coast. In addition, coastal meteorology was not adequately represented by the monitoring site in Seaford. In 1997 the Lewes site was established on the property of the University of Delaware College of Earth, Ocean, and Environment Hugh R. Sharp Campus. The site meets all EPA siting criteria. The monitoring objectives include NAAQS compliance, population exposure, and trends.

Figure 15: O_3 Pollution Rose - Lewes
Wind data source: Georgetown Delaware Coastal Airport, NOAA LCD
**note this is an inland Airport vs a coastal site*



High hourly O_3 concentrations in 2019 occurred from the northeast. Historically, higher concentrations are more frequently seen with the southwesterly wind directions.

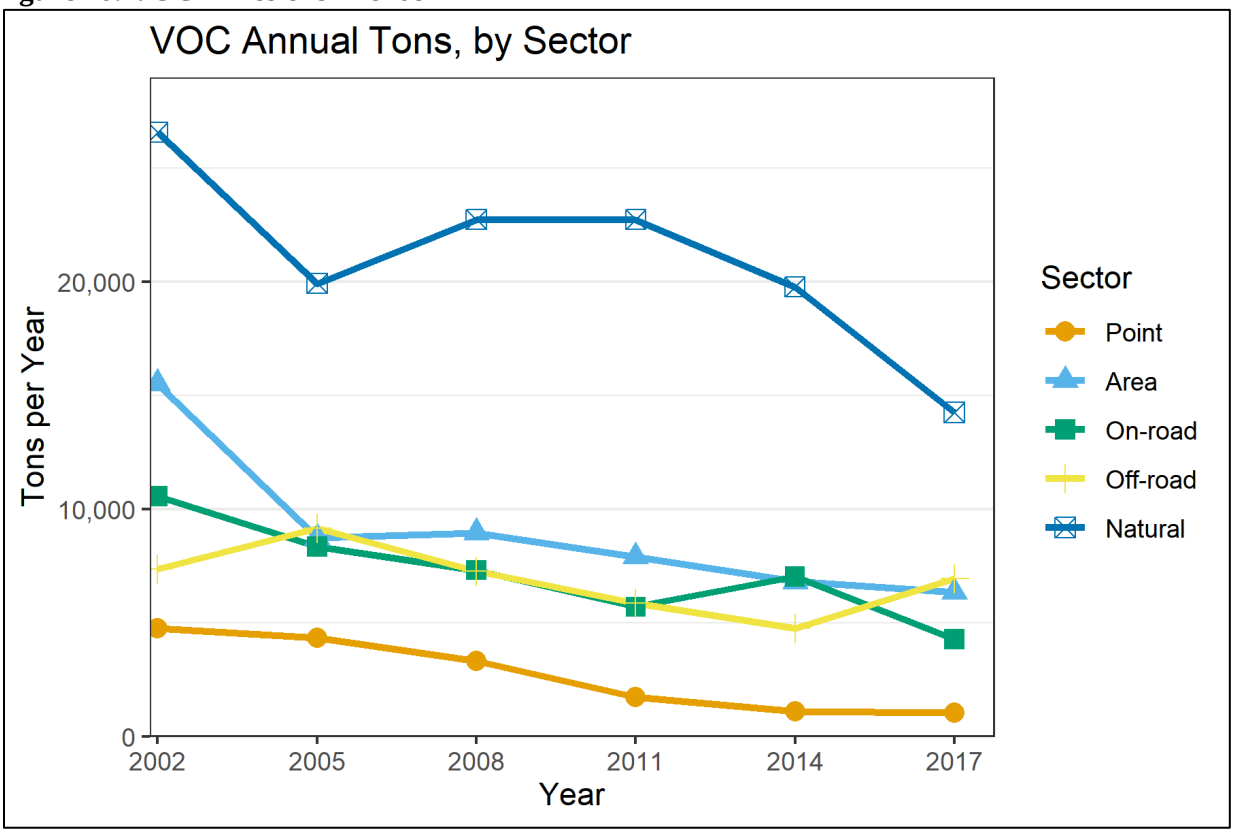
Emissions Info and Maps

Trends – Statewide from 2017 National Emissions Inventory (NEI)

Emissions in most categories have trended downward. This correlates with the improvement in ambient O_3 levels. O_3 is rarely a directly emitted pollutant, but rather a byproduct of precursors, which include volatile organic compounds (VOCs), oxides of nitrogen (NO_x), and carbon monoxide (CO). Trends for VOCs are indicated below while NO_x (NO_2 Section) and CO are discussed in their respective sections of this report.

More information on the National Emissions Inventory including data is available from the EPA's NEI page.

Figure 16: VOC Emissions Trends



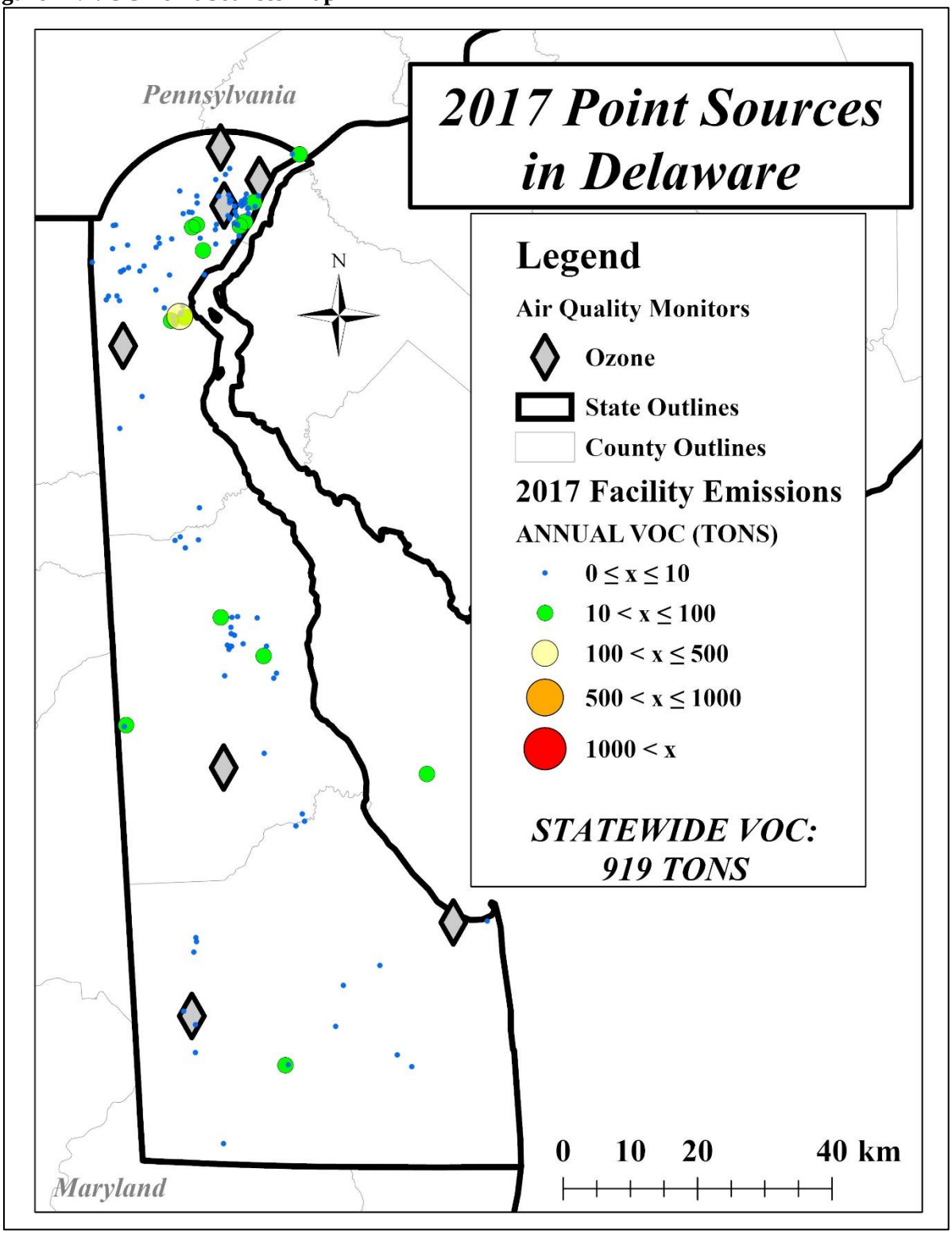
Maps - Point Sources and Contribution

Top 5 VOC Facilities from the most recent National Emissions Inventory (2017).

- Delaware City Refinery
- Port of Wilmington
- Magellan Terminals Holdings, LP
- Formosa Plastics Corporation (facility shut down)
- Marcus Hook Industrial Complex

A point source map with Ozone monitors indicated as pins included on the following page. Note that VOCs are monitored at the Wilmington MLK NCore site and will be included as part of the PAMS program.

Figure 17: VOC Point Sources Map



Statistical analyses

Ozone sites in Delaware have shown steadily improving air quality since the 1980s. The O_3 design value chart shows the 8-hour design value trends for each site in comparison current NAAQS. Data for individual sites is included on the following page.

In the 1990s there were greater differences in design values between sites in New Castle compared to sites in the other counties. Since 2000, concentrations have shown increasing similarity throughout the state. In 2015 the NAAQS was set at 0.070 ppm. Since then all but three site's design values have been below the standard. The trend at those three above the current standard is trending downwards. The Philadelphia CBSA design values remain above the standard and New Castle County being part of the CBSA remains designated Non-Attainment.

Figure 18: O_3 Design Value Trends
3 Year Average 4th Maximum 8-hour Average (ppm)

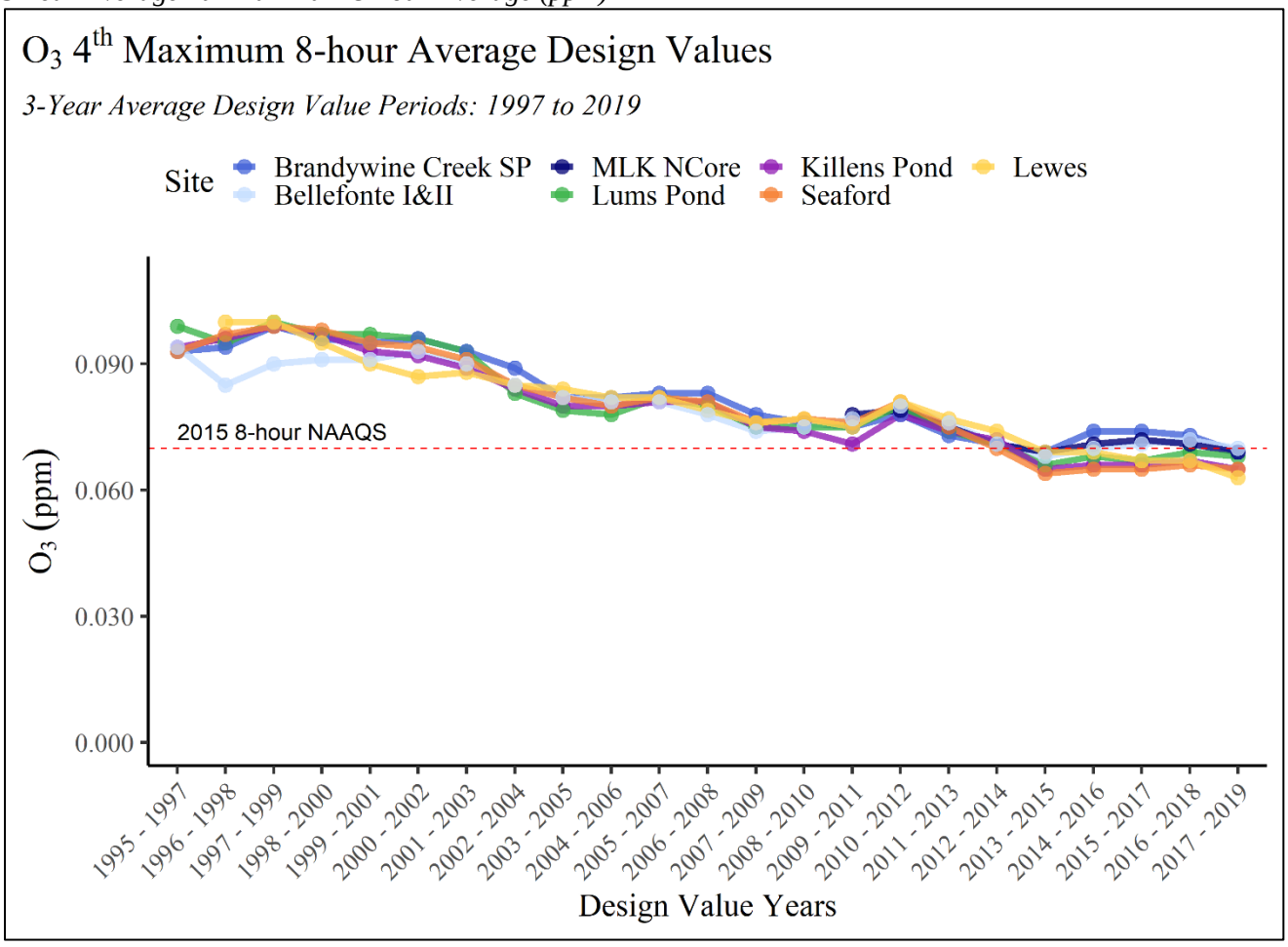


Table 9: O_3 8-hour Design Values by Site (ppm)

3 Year Average 4th Maximum 8-hour Average

Notes: Design Value Year is the second indicated year, 2000-2002 is DV Year 2002 & includes 2000, 2001, & 2002. 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

5-Year Assessment	Years	BCSP	Bellefonte I & II	Lums Pond	MLK NCore	Killens Pond	Seaford	Lewes
2010	2000-2002	0.096	0.092	0.096		0.092	0.094	0.087
	2001-2003	0.093	0.090	0.093		0.089	0.091	0.088
	2002-2004	0.089	0.085	0.084		0.084	0.085	0.085
	2003-2005	0.082	0.082	0.080		0.080	0.082	0.084
	2004-2006	0.082	0.081	0.078		0.080	0.080	0.082
	2005-2007	0.083	0.081	0.082		0.081	0.082	0.082
	2006-2008	0.083	0.078	0.080		0.081	0.081	0.079
	2007-2009	0.078*	0.074	0.075		0.075	0.076	0.076
2015	2008-2010	0.076*	0.075	0.075		0.074	0.077	0.077
	2009-2011	0.075*	0.077	0.075		0.071	0.076	0.075
	2010-2012	0.078*	0.080	0.080	0.079*	0.078	0.081	0.081
	2011-2013	0.073*	0.076	0.074	0.075*	0.074	0.075	0.077
	2012-2014	0.071*	0.071	0.071	0.071	0.072	0.070	0.074
2020	2013-2015	0.069*	0.068	0.066	0.069	0.065	0.064	0.069
	2014-2016	0.074*	0.070	0.068	0.071	0.066	0.065	0.069
	2015-2017	0.074	0.071	0.067	0.072	0.066	0.065	0.067
	2016-2018	0.073*	0.072	0.069	0.071	0.067	0.066	0.067
	2017-2019	0.069*	0.070	0.068*	0.069	0.065	0.065	0.063

* One or more years with less than 75% data completeness

Two most recent Delaware O_3 design values and percent difference from the 2015 NAAQS:

Table 10: Two Most Recent Design Value Years NAAQS Comparison

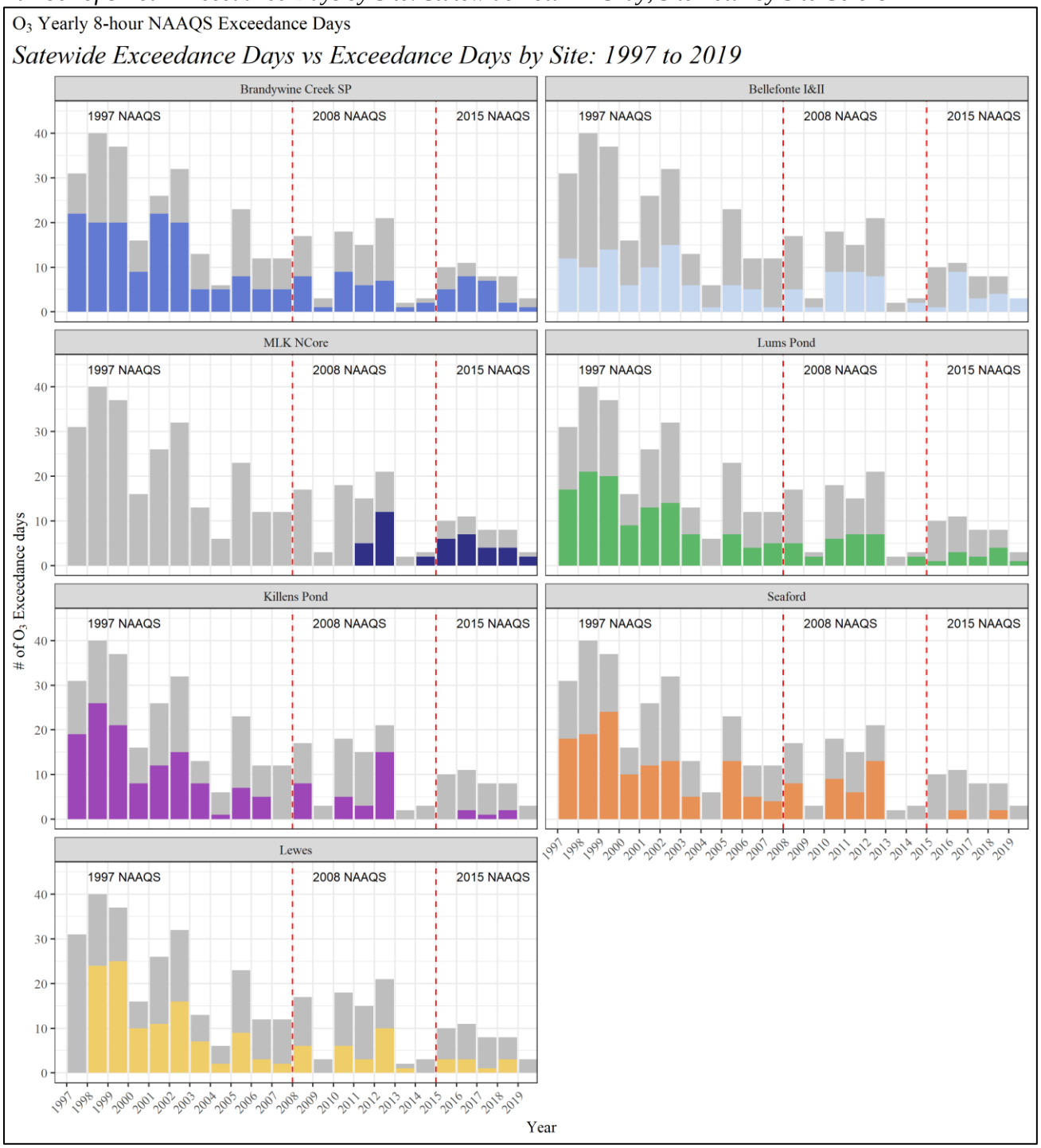
County	Site	2016-2018 DV ppm	% Δ current 2015 NAAQS 0.070 ppm	2017-2019 DV ppm	% Δ current 2015 NAAQS 0.070 ppm
New Castle	Brandywine Creek	0.073	4	0.069	-1
New Castle	Bellefonte II	0.072	3	0.070	0
New Castle	Lums Pond	0.069	-1	0.068	-3
Kent	Killens Pond	0.067	-4	0.065	-7
Sussex	Seaford	0.066	-6	0.065	-7
Sussex	Lewes	0.067	-4	0.063	-10

For the current design values for all three counties are below or very close to the 2015 8-hour NAAQS.

The number of days with 8-hour concentrations exceeding the level of the current NAAQS of 0.070 ppm is shown below. The trend has been downward with increasingly similar numbers of exceedance days across all sites.

Table 11: O_3 Exceedance Day Trends

Number of 8-hour Exceedance Days by Site: Statewide Total in Gray, Site Total by Site Colors



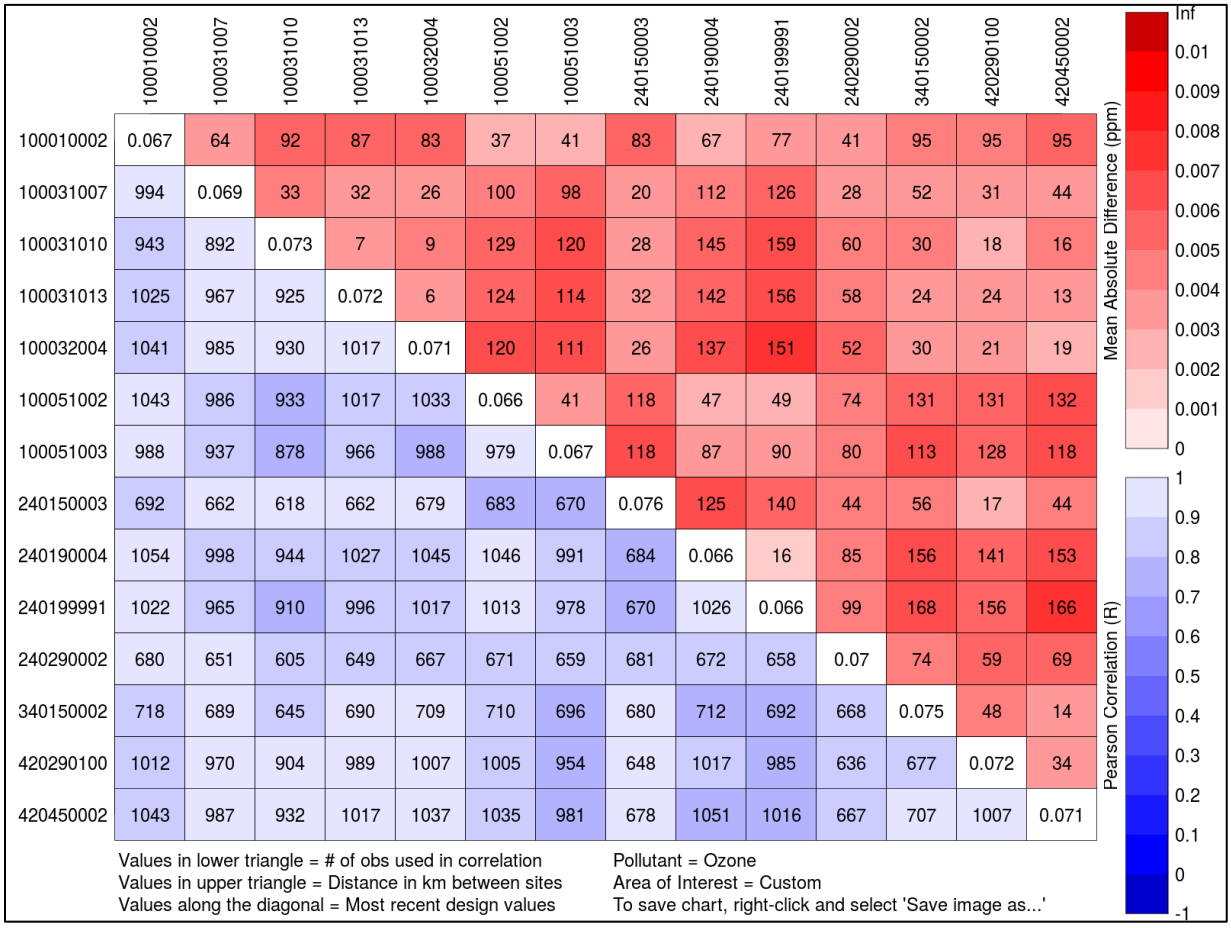
Correlation Matrix

In 2010 EPA provided a data analysis tool to examine correlation coefficients between sites. According to EPA, the purpose of this analysis/tool was to provide a means of determining possible redundant sites that could be removed. Possible redundant sites would exhibit fairly high correlations consistently across all of their pairings and would have low average relative difference despite the distance. Usually, it is expected that correlation between sites will decrease as distance increases. However, for a regional air pollutant such as O_3, sites in the same air shed can have very similar concentrations and be highly correlated. More unique sites would exhibit the opposite characteristics; they would not be very well correlated with other sites and their relative difference would be higher than other site to site pairs.

In 2020 the NetAssess application was developed and updated by the EPA's Office of Air Quality Planning and Standards (OAQPS). The tool was based on the 2015 NetAssess by a LADCO (Lake Michigan Air Directors Consortium) workgroup consisting of people from Indiana, Minnesota, and Michigan focusing on the 2015 network assessment. The NetAssess tool is an update to the original Network Assessment tools developed by Mike Rizzo for the 2010 assessment. The NetAssess tool can be found at https://github.com/USEPA/NetAssess2020/. The tool uses data from the national air quality database (AQS) from 2016 through 2018.

Using the tool to examine the O_3 monitoring sites in Delaware along with the nearest sites in adjoining states (Maryland, Pennsylvania, and New Jersey) in the same air shed, produced the following results.

Figure 19: Net Assess Correlation Matrix – DE and nearby state O_3 sites
DV Year: 2016-2018



As described in the NetAssess App documentation, the correlation between two sites quantitatively describes the degree of relatedness between the measurements made at two sites. That relatedness could be caused by various influences including a common source affecting both sites to pollutant transport caused meteorology. The correlation, however, may indicate whether a pair of sites is related, but it does not indicate if one site consistently measures pollutant concentrations at levels substantially higher or lower than the other. For this purpose, the daily relative difference is defined as:

$$\frac{abs(s1-s2)}{avg(s1,s2)}$$

where "s1" and "s2" represent the O_3 concentrations at sites one and two in the pairing, "abs" is the absolute difference between the two sites and "avg" is the average of the two site concentrations.

The average relative difference between the two sites is an indicator of the overall measurement similarity between the two sites. Site pairs with a lower average relative difference are more similar to each other than pairs with a larger difference. Both the correlation and the relative difference between sites are influenced by the distance by which site pairs are separated. Usually, sites with a larger distance between them will generally be more poorly correlated and have large differences in the corresponding pollutant concentrations.

Table 12: Correlation data (R^2) for O_3 sites
DV Year 2016 – 2018, State sites shaded

AQS Site ID	10-001-0002	10-003-1007	10-003-1010	10-003-1013	10-003-2004	10-005-1002	10-005-1003	24-015-0003	24-019-0004	24-019-9991	24-029-0002	34-015-0002	42-029-0100
10-003-1007	0.91												
10-003-1010	0.86	0.92											
10-003-1013	0.87	0.94	0.95										
10-003-2004	0.87	0.96	0.94	0.96									
10-005-1002	0.95	0.86	0.80	0.82	0.83								
10-005-1003	0.93	0.82	0.76	0.80	0.79	0.91							
24-015-0003	0.84	0.95	0.95	0.94	0.95	0.78	0.73						
24-019-0004	0.94	0.86	0.81	0.82	0.82	0.95	0.89	0.77					
24-019-9991	0.92	0.85	0.79	0.82	0.81	0.94	0.88	0.77	0.97				
24-029-0002	0.95	0.94	0.88	0.90	0.89	0.89	0.84	0.90	0.88	0.86			
34-015-0002	0.86	0.92	0.90	0.94	0.93	0.81	0.79	0.90	0.78	0.78	0.90		
42-029-0100	0.86	0.93	0.97	0.94	0.95	0.80	0.77	0.96	0.80	0.79	0.86	0.88	
42-045-0002	0.84	0.92	0.93	0.95	0.96	0.80	0.78	0.91	0.79	0.79	0.86	0.93	0.93

DE
MD
NJ
PA

Table 13:Correlation data - average relative differences for O_3 sites
DV Year 2016 – 2018, State sites shaded

AQS Site ID	10-001-0002	10-003-1007	10-003-1010	10-003-1013	10-003-2004	10-005-1002	10-005-1003	24-015-0003	24-019-0004	24-019-9991	24-029-0002	34-015-0002	42-029-0100
10-003-1007	0.004												
10-003-1010	0.005	0.004											
10-003-1013	0.005	0.003	0.003										
10-003-2004	0.006	0.003	0.004	0.003									
10-005-1002	0.002	0.005	0.006	0.006	0.006								
10-005-1003	0.003	0.005	0.006	0.006	0.007	0.003							
24-015-0003	0.005	0.003	0.003	0.004	0.004	0.006	0.006						
24-019-0004	0.003	0.005	0.006	0.006	0.007	0.003	0.004	0.006					
24-019-9991	0.003	0.005	0.006	0.006	0.007	0.003	0.004	0.006	0.002				
24-029-0002	0.003	0.003	0.005	0.005	0.005	0.004	0.005	0.004	0.004	0.004			
34-015-0002	0.005	0.004	0.004	0.003	0.003	0.006	0.006	0.004	0.006	0.006	0.005		
42-029-0100	0.005	0.004	0.003	0.004	0.004	0.006	0.006	0.003	0.006	0.006	0.005	0.004	
42-045-0002	0.006	0.004	0.004	0.003	0.003	0.006	0.007	0.004	0.007	0.007	0.006	0.003	0.004

DE
MD
NJ
PA

The Delaware sites are correlated with each other (R^2 from 0.76 – 0.95) with fairly low average differences. The sites farthest from each other, as expected, show the lowest correlation and highest difference. Looking at sites outside Delaware, there was a slightly wider range of correlation (R^2 from 0.73 – 0.97), again largely increasing with greater distance between the sites.

The conclusion is that there is some correlation among all sites, with slightly stronger correlation among the closest sites. The decreasing variation in overall O_3 concentrations noted in the design value statistics over recent years is reflected in the increasing level of correlation and relative difference among O_3 sites in Delaware and nearby states over the past five years.

Removal Bias

The removal bias tool is meant to aid in determining redundant sites. The bias estimation uses the nearest neighbors to each site to estimate the concentration at the location of the site if the site had never existed. This is done using the Voronoi Neighborhood Averaging algorithm with inverse distance squared weighting. The squared distance allows for higher weighting on concentrations at sites located closer to the site being examined. The bias was calculated for each day at each site by taking the difference between the predicted value from the interpolation and the measured concentration. A positive average bias would mean that if the site being examined was removed, the neighboring sites would indicate that the estimated concentration would be larger than the measured concentration. Likewise, a negative average bias would suggest that the estimated concentration at the location of the site is smaller than the actual measured concentration.

Figure 20: NetAssess O_3 site Removal Bias map output

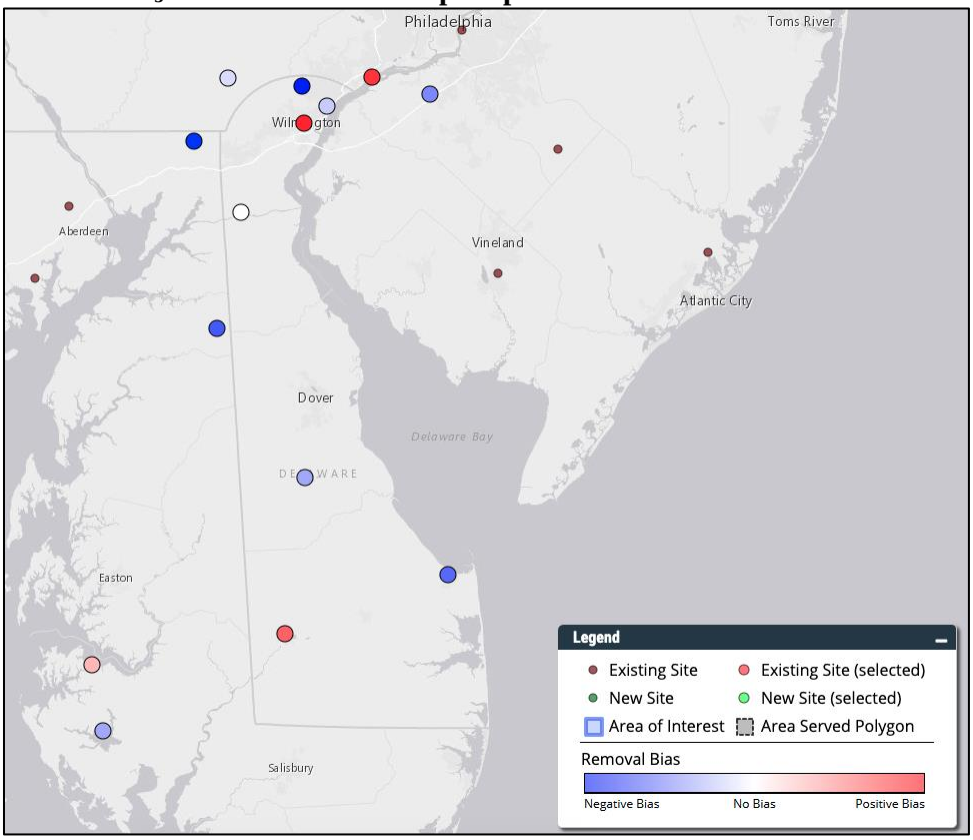


Table 14: NetAssess O_3 Removal Bias results

AQS Site ID	Site Name	Design Value 2016-2018 (ppm)	Mean Removal Bias	Removal Bias St.Dev.	Mean Relative Bias (%)
10-001-0002	Killens Pond	0.067	-0.0005	0.0022	-1.1
10-003-1007	Lums Pond	0.069	0.0000	0.0029	-0.3
10-003-1010	BCSP	0.073	-0.0016	0.004	-4.4
10-003-1013	Bellefonte II	0.072	-0.0003	0.0033	0.8
10-003-2004	MLK NCore	0.071	0.0013	0.0037	5.8
10-005-1002	Seaford	0.066	0.0009	0.0027	3.5
10-005-1003	Lewes	0.067	-0.0009	0.0036	-1.8

From this analysis, some level of bias either negative or positive (depending on the site) would be introduced to design value calculations by removing any site in Delaware. However, removal of Lums Pond would have minimal impacts based on the 2018 Design Value year.

Other Considerations

Since the 2015 assessment, some monitoring equipment has been updated, however all but two O_3 analyzers are older than the recommended age of 7 years (most are 8 to 9 years old). These should be considered for replacement as resources become available.

Future needs

While the 2019 ozone season saw the Design Values drop at or below the standard, continued monitoring will be required to observe if this trend continues. As funds become available monitors and shelters will need to be replaced. The full implementation of the PAMS program is expected to begin by the summer of 2021.

Summary information and monitor rating for O_3 – critical criteria shown in **bold**

Table 15: O_3 Monitor Ratings

Site	Data Criteria: % NAAQS, Max Concentration, Longevity, AQI	Statistical Criteria: Measurement Criticality, Uniqueness, Trends	Situational Criteria: Meteorological Pattern, Area Scale, Area Represented, Federal Requirements, Multi-pollutant	Future Needs, Special Considerations: Impact from NAAQS Revisions, Concentration Gradient, Source-impact, Cost, Community	Rating
Brandywine Creek	% NAAQS: Close to Current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Measurement Criticality: Removal Bias** Uniqueness: Moderate Correlation	**Meteorological Pattern: Secondary Downwind Direction Wilmington**		**Critical**
Bellefonte II	% NAAQS: Close to Current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	Measurement Criticality: **Removal Bias** Uniqueness: Moderate Correlation	**Meteorological Pattern: Primary Downwind Direction Wilmington**	Concentration Gradient: between Wilmington and nearby PA/Philadelphia	**Critical**
MLK NCore	% NAAQS: Close to Current NAAQS Longevity: Moderate trend history Max Concentration: not Design Value AQI Calculated	**Measurement Criticality: Removal Bias** Uniqueness: Moderate Correlation	**NCore Required monitor**		**Critical**
Lums Pond	% NAAQS: Close to Current NAAQS Longevity: Long trend history Max Concentration: not Design Value AQI Calculated	**Measurement Criticality:** No Removal Bias Uniqueness: Moderate Correlation	Meteorological Pattern: Upwind Wilmington **Federal Requirement: Transport from Baltimore/Washington Area**		**Critical**
Killens Pond	% NAAQS: Close to Current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Measurement Criticality: Removal Bias** Uniqueness: Moderate Correlation	**Area Represented: Only site in Kent Co., closest to Dover MSA** **Federal Requirement: Rural Background**		**Critical**
Seaford	% NAAQS: Close to Current NAAQS Longevity: Long trend history Max Concentration: Not Design Value AQI Calculated	**Measurement Criticality: Removal Bias** Uniqueness: Moderate Correlation	**Area represented: Salisbury MSA**		**Critical**
Lewes	% NAAQS: Close to Current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Measurement Criticality: Removal Bias** Uniqueness: Moderate Correlation	**Area Represented: Only Coastal Site, significant seasonal population exposure**	Population growth expected to continue, correlation with some sites declining	**Critical**

Particulate Matter - Fine ($PM_{2.5}$)

Current $PM_{2.5}$ sites

$PM_{2.5}$ is a priority pollutant in Delaware because concentrations remain close to the NAAQS, particularly in the urban Wilmington area. In 2012, New Castle County reached attainment for the NAAQS separate from the Philadelphia CSA, so at this time the entire state is in attainment. Despite improving ambient concentrations, there continue to be some days with unhealthy levels of $PM_{2.5}$ in the state, particularly in New Castle County.

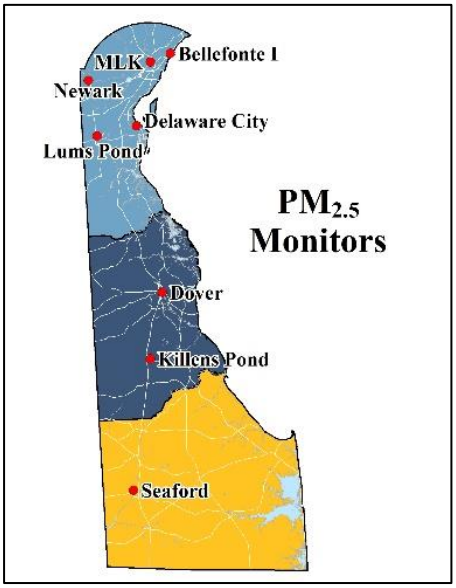


Figure 21: DE $PM_{2.5}$ Monitor Map

Delaware operates either manual Federal Reference Method (FRM) or continuous Federal Equivalent Method (FEM) $PM_{2.5}$ monitors at seven sites throughout the state. All monitors operate year-round. Collocated FRM samples are taken at the MLK site. Delaware is in the process of replacing its manual FRM samplers with continuous FEM monitors at most sites. The MLK and Lums Pond sites are exceptions, where FRM and FEM monitors are collocated.

The normal EPA National Sampling Schedule for manual samplers is 24 hours every three days as specified. However, at MLK samples are collected every day and a collocated sample collected every sixth day. Continuous FEM monitors generate data at hourly and 24-hour intervals. Continuous monitors help support the goal of AQI forecasting.

Monitoring Requirements

State agencies must operate at least the minimum number of required $PM_{2.5}$ sites listed in 40 CFR Part 58 Appendix D Table D-5. These required monitoring stations or sites must be sited to represent community-wide air quality. In addition, the following specific criteria apply:

(1) At least one monitoring station is to be sited in a population-oriented area of expected maximum concentration (MLK Wilmington).
(2) For areas with more than one required station, a monitoring station is to be sited in an area of poor air quality.
(3) Each State shall install and operate at least one $PM_{2.5}$ site to monitor for regional background (Killens Pond) and at least one $PM_{2.5}$ site to monitor regional transport (Lums Pond).

$PM_{2.5}$ Speciation

Chemical speciation is encouraged at sites where the chemically resolved data would be useful in developing State implementation plans and supporting atmospheric or health effects related studies. These sites in Delaware were originally at MLK in Wilmington and Dover in Kent County. The $PM_{2.5}$ chemical speciation sites include analysis for specific elements, selected anions/cations, and carbon collected on a 1-in-6 day schedule.

In 2014 EPA completed the process of assessing the national speciation network. The purpose of the assessment was to create a network that is sustainable going forward with the current situation of reduced federal funding by redistributing resources to new or high priorities from those of low-priority or low-benefit. As part of this process EPA developed a scoring metric to identify existing speciation sites of lower value for defunding, and the Dover site was identified as low-value due to redundancy. Speciation monitoring at the Dover site therefore ended in 2014 in response to termination of support from the EPA. Speciation monitoring continues at the MLK site in Wilmington on a 1-in-3 day schedule.

Table 16: Delaware $PM_{2.5}$ Monitoring Sites

Site	County/MSA	Objectives and Monitor Type
Bellefonte I	New Castle Phil. CSA	NAAQS compliance Population exposure Trends
MLK	New Castle Phil. CSA	NAAQS compliance Population exposure/Max. concentration Expected poor air quality Trends Speciation Continuous monitor for AQI
Newark	New Castle Phil. CSA	NAAQS compliance Population exposure Trends
Lums Pond	New Castle Phil CSA	NAAQS compliance Regional transport Upwind for Wilmington Trends Continuous monitor for AQI
Delaware City (Rt 9)	New Castle Phil CSA	NAAQS compliance Regional transport Trends Continuous monitor for AQI
Dover	Kent Dover MSA	NAAQS compliance Population exposure Trends
Killens Pond	Kent Not in MSA	NAAQS compliance Regional background Trends Continuous monitor for AQI
Seaford	Sussex Salisbury MSA	NAAQS compliance Population exposure Trends Continuous monitor for AQI

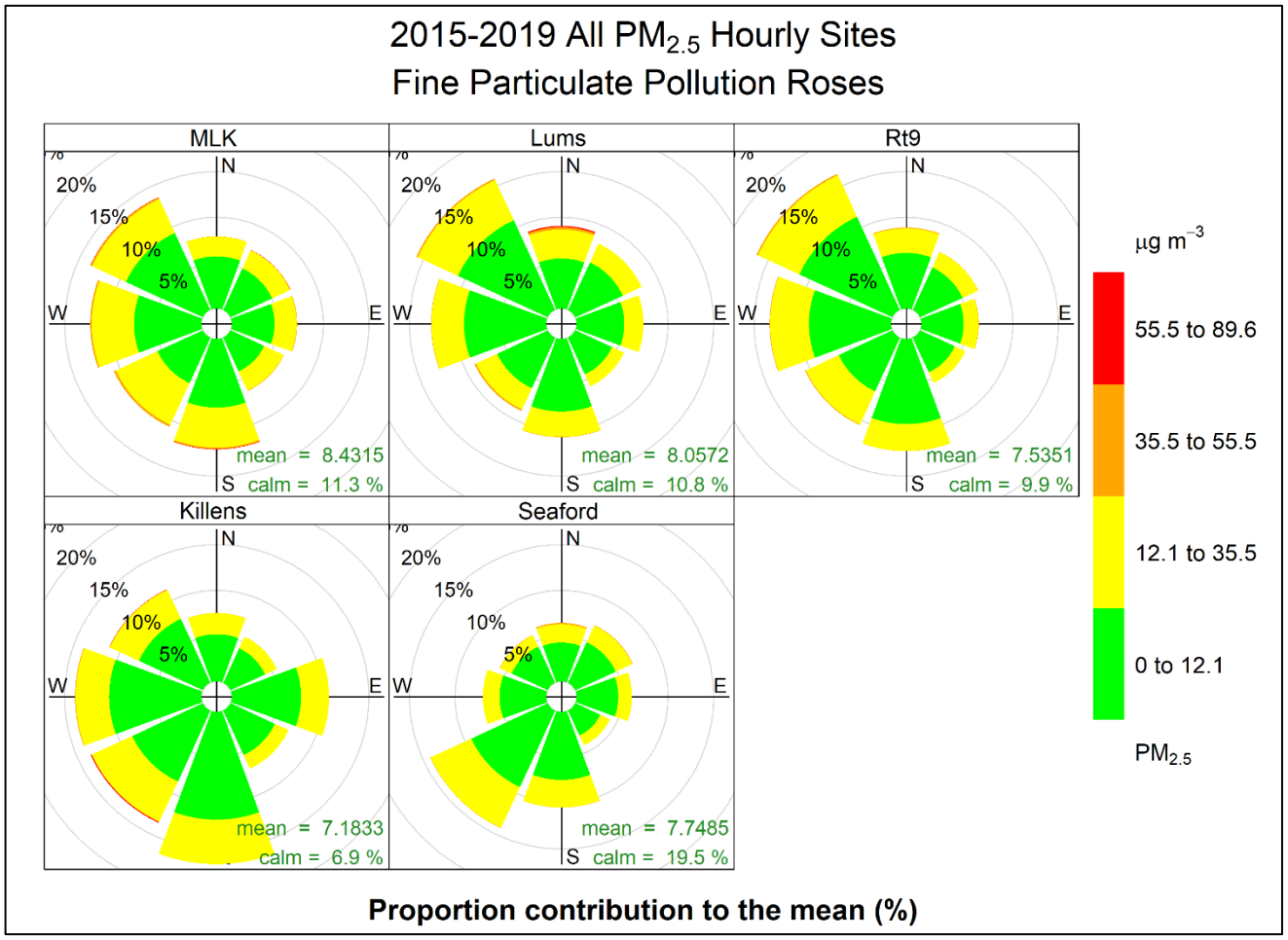
Situational analyses

Note on pollution roses – because the $PM_{2.5}$ data represents 24-hour averages, traditional pollution roses are not available; if hourly continuous $PM_{2.5}$ data is available, pollution roses were generated. Meteorological data for pollution roses was obtained from the NOAA Local Climatological Database (LCD), unless otherwise noted. Refer to the Meteorological Summary section for more details on wind data sources.

The standard is still based on a 24-hour average, however newer technology has allowed for hourly observations. The highest hourly average concentrations over the past 5 years vary by site, but in general come from winds with a westerly or northerly component.

Figure 22: Pollution Roses for All Continuous $PM_{2.5}$ Monitoring Sites

Note: Not all sites had continuous monitors available from 2015-2019 and the technology used at each site has changed over time. See site analyses following for more information.



Platform Sites – 24-hour Measurements Only

New Castle County sites

Bellefonte I (10-003-1003) The Bellefonte site was established in 1969 to monitor O_3 and SO_2; $PM_{2.5}$ monitoring began in 1999. Bellefonte $PM_{2.5}$ is neighborhood scale and the objectives are compliance with the NAAQS, population exposures, and trends. Bellefonte is also used to determine concentration gradients between Wilmington and monitors in Chester, PA. Bellefonte meets all EPA siting criteria.

Newark (10-003-1012) The original Newark site (10-003-1011) was established in 1999 in central Newark on University of Delaware property and operated for almost one year before land use changes required it to be relocated. The current site was established in 2000 as a platform only and is located on the north campus of the UD. It is a $PM_{2.5}$ neighborhood scale site. The location is suburban and generally impacted by mobile sources and regional transport. The site meets all EPA siting criteria. The objectives are NAAQS compliance, regional transport, population exposure, and trends.

Kent County site

Dover (10-001-0003) The Dover site was established in 1999 and is a platform only. It is a neighborhood scale site representative of the Dover area and is impacted by a combination of source types including mobile, large and small point sources. The site meets all EPA siting criteria. The monitoring objectives are NAAQS compliance, population exposure, and trends. Speciation monitoring discontinued at this location in 2014.

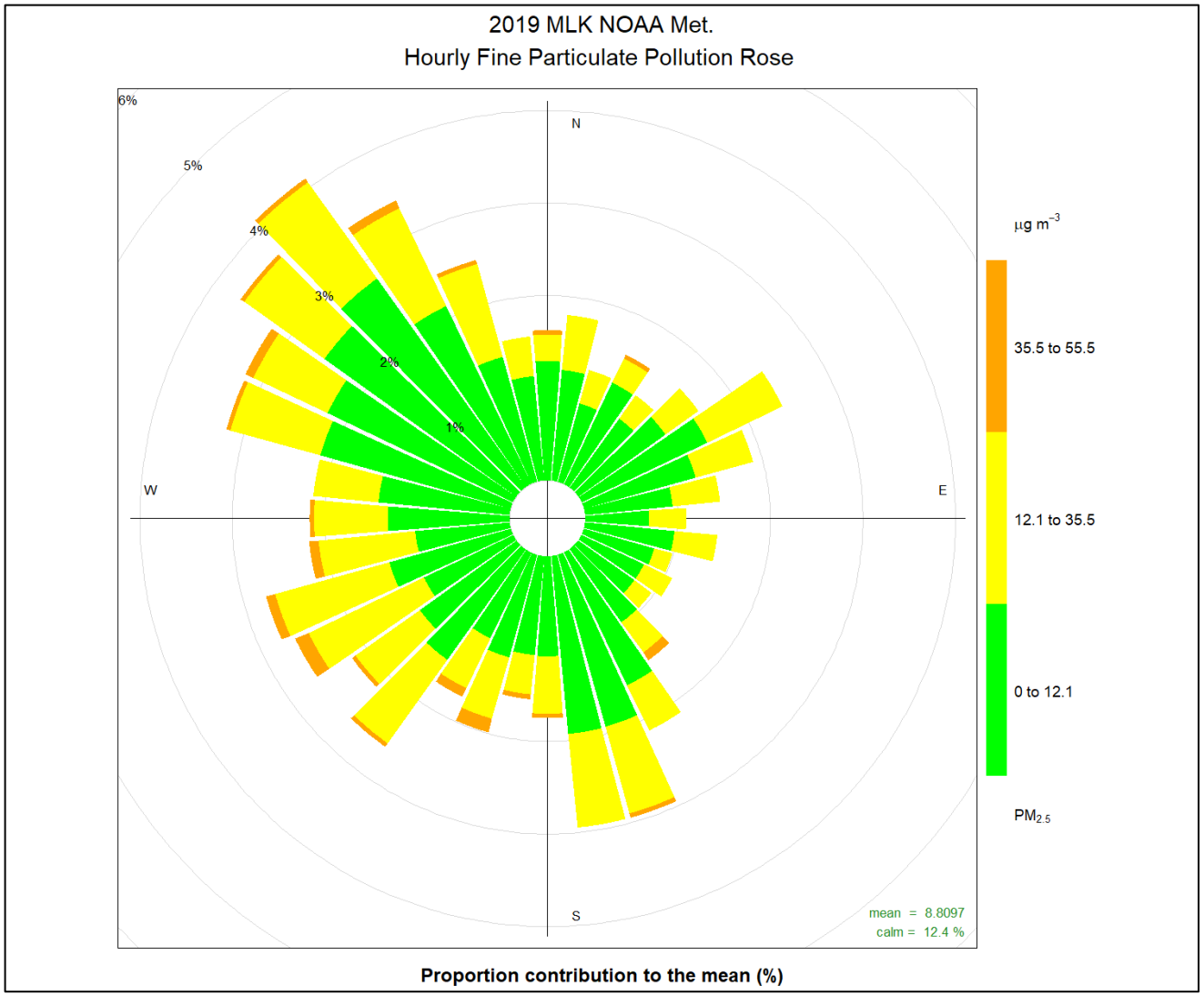
New Castle County sites and characteristics

MLK (10-003-2004) The MLK site is located in Wilmington at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years. The MLK site represents urban population exposure to multiple pollution sources. The site meets all EPA siting criteria. Monitoring objectives are compliance with the NAAQS, maximum population exposure, and trends. NCore monitoring began during 2010 with all monitors fully operational on January 1, 2011.

Continuous $PM_{2.5}$ monitoring using an FRM-like method (Thermo-Fisher SHARP monitor) began at this site in 2007 (Method later designated FEM). In 2018 the SHARP monitor was replaced with an EPA designated FEM Teledyne Advanced Pollution Instrumentation (T-API or TAPI) T640 and is continuing in support of data analysis, diurnal pattern assessment, and AQI generation. Hourly data are submitted to the AirNow website and the AQS database.

Figure 23: $PM_{2.5}$ Pollution Rose – MLK NCore (Wilmington)

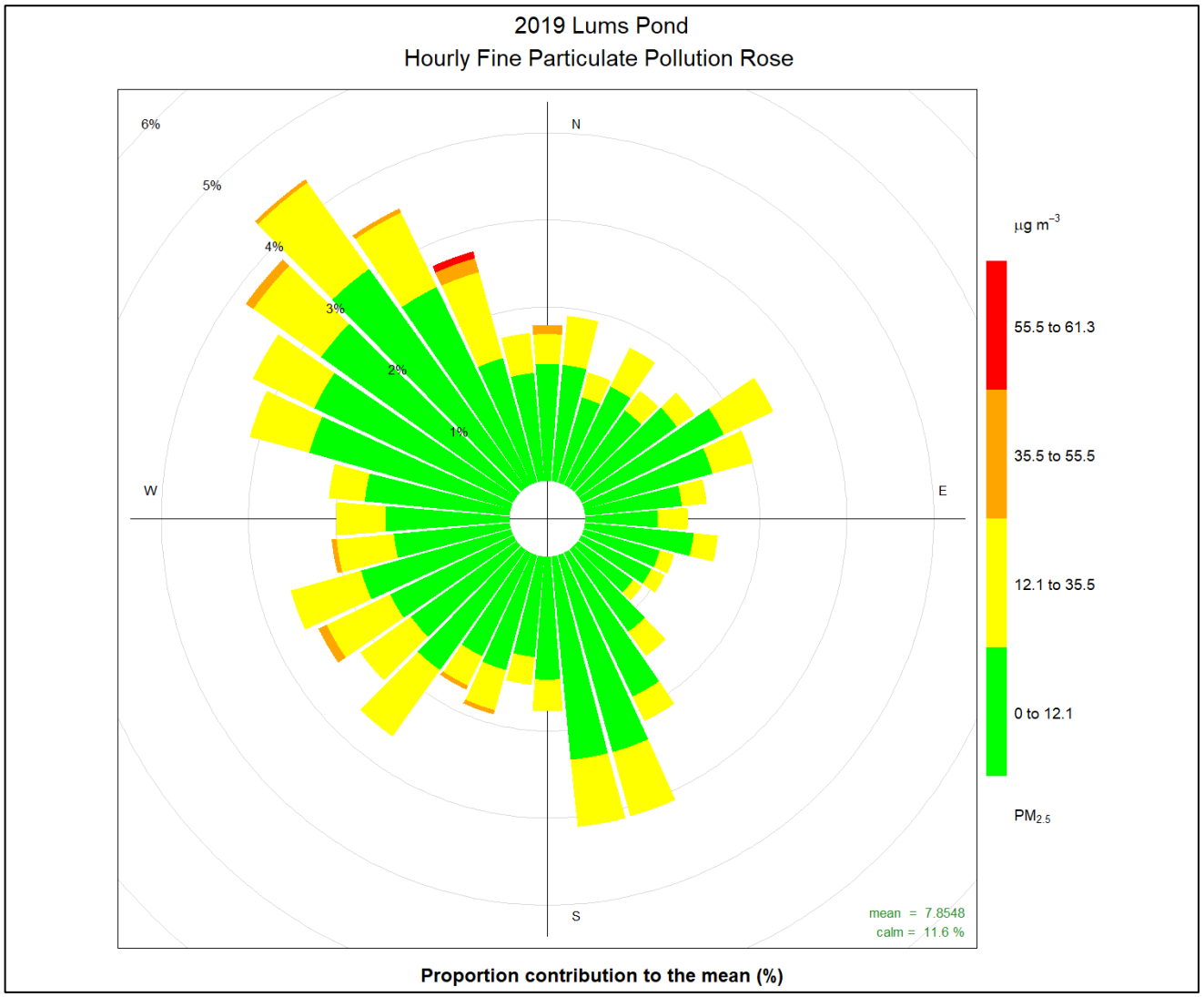
Met Data Source: Wilmington New Castle County Airport, NOAA LCD



High hourly $PM_{2.5}$ concentrations show limited directionality, but there are more frequent instances of elevated $PM_{2.5}$ with wind with a westerly component.

Lums Pond (10-003-1007) The Lums Pond site is a neighborhood scale site located in Lums Pond State Park and is the general upwind direction from Wilmington. The immediate area is rural. The site meets all EPA siting criteria. $PM_{2.5}$ monitoring began in 1999. Monitoring objectives are regional transport, general population exposure, trends, and NAAQS compliance. In 2018 an EPA designated FEM TAPI T640 was installed as the primary $PM_{2.5}$ monitor. To satisfy requirements in 40 CFR Part 58, Appendix A, Section 3.2.5, the FRM is collocated with the FEM.

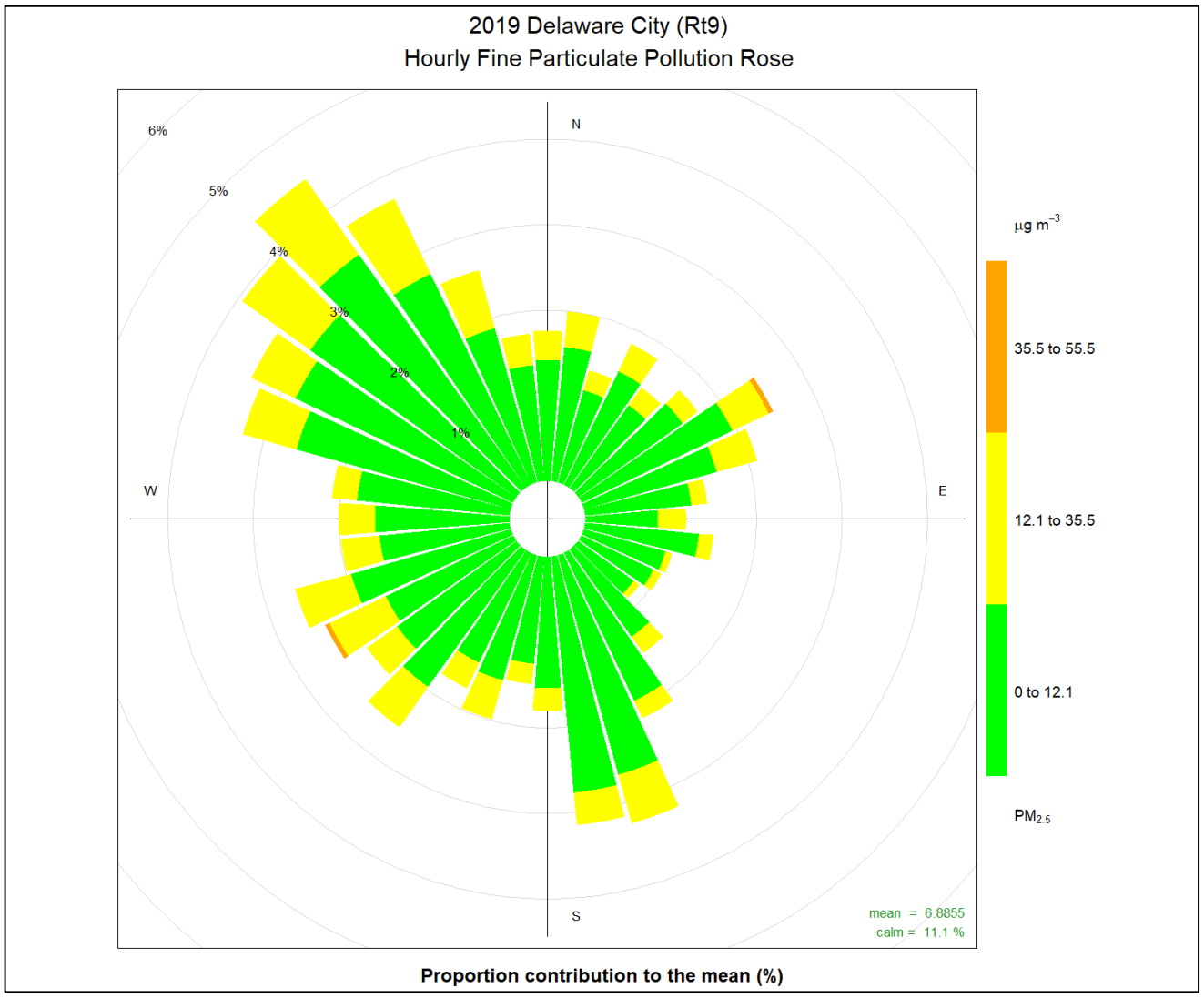
Figure 24: $PM_{2.5}$ Pollution Rose – Lums Pond
Wind data source: Wilmington New Castle County Airport, NOAA LCD



High hourly $PM_{2.5}$ concentrations occur most frequently in winds with a westerly component.

Delaware City (10-003-1008) The Delaware City site has not had a $PM_{2.5}$ FRM monitor. In 2013 Delaware added an FEM Thermo SHARP continuous $PM_{2.5}$ monitor to the Delaware City site as a SPM monitor which operated for over two years, at which time the designation changed from SPM to SLAMS in 2016. In 2018 an EPA designated FEM TAPI T640 replaced the SHARP monitor as the primary $PM_{2.5}$ monitor.

Figure 25: $PM_{2.5}$ Pollution Rose – Delaware City
Wind data source: Wilmington New Castle County Airport, NOAA LCD



High hourly $PM_{2.5}$ concentrations show limited directionality, but there are more frequent instances of elevated $PM_{2.5}$ with wind with a westerly component.

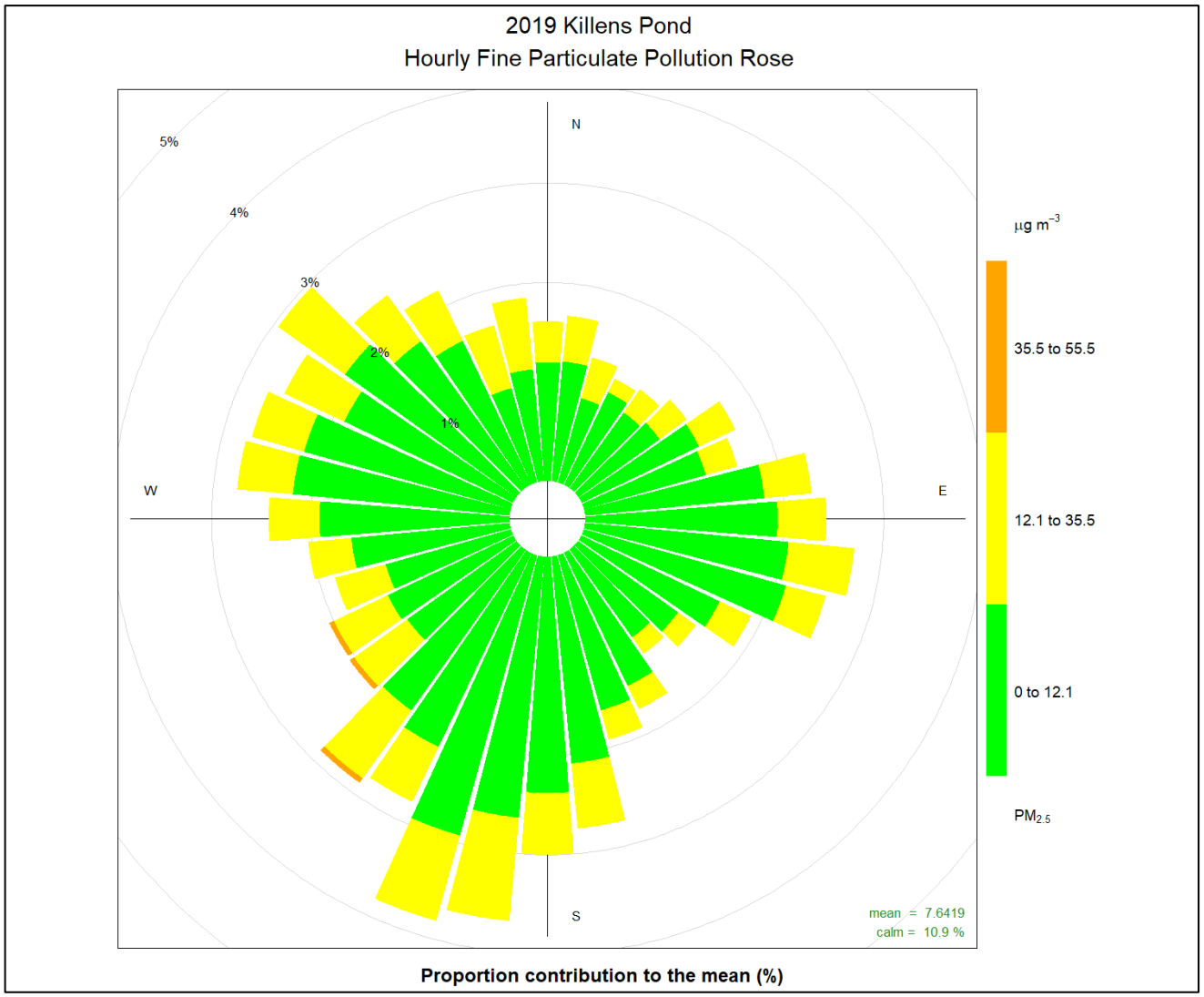
Kent county sites and characteristics

Killens Pond (10-001-0002) The Killens Pond site was established in 1997 and is located in a rural area that is part of Killens Pond State Park. $PM_{2.5}$ monitoring began at this site in 1999. The site meets all EPA siting criteria. The objectives for this site are regional background concentrations, NAAQS compliance, and trends.

Continuous $PM_{2.5}$ monitoring using a non-FRM-like method began at this site in 2003 and was replaced with an FEM SHARP monitor in support of data analysis, diurnal pattern assessment, and AQI generation. In 2018 an EPA designated FEM TAPI T640 replaced the SHARP monitor and was designated as the primary $PM_{2.5}$ monitor beginning in 2019. At the end of 2018 monitoring with the FRM ceased. This is the only $PM_{2.5}$ monitor in Kent County.

Figure 26: $PM_{2.5}$ Pollution Rose – Killens Pond

Wind data source: Dover Airforce Base, NOAA LCD



High hourly $PM_{2.5}$ concentrations show limited directionality, but there are more frequent instances of elevated $PM_{2.5}$ with wind with a westerly component.

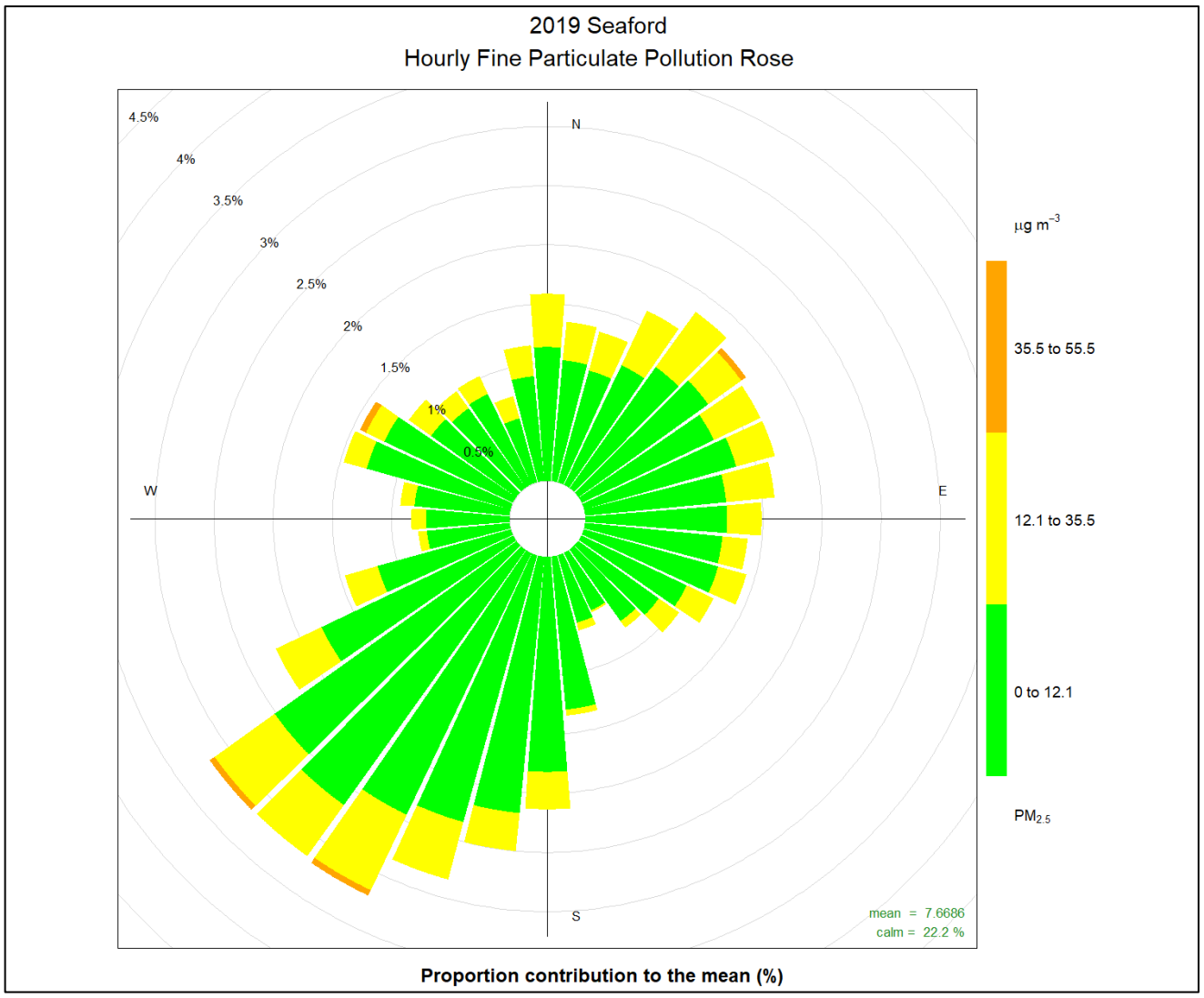
Sussex county sites and characteristics

Seaford (10-005-1002) The Seaford site was established in 1990 at the current site on Virginia Ave, and $PM_{2.5}$ monitoring began in 1999. The site is neighborhood scale and is suburban. The site is impacted by local point sources, mobile sources, and regional transport. The site meets all EPA siting criteria. The site objectives are NAAQS compliance, population exposure, and trends.

Continuous $PM_{2.5}$ monitoring using a non-FRM-like method began at this site in 2003 and was replaced with an FEM SHARP monitor in support of data analysis, diurnal pattern assessment, and AQI generation. In 2018 an EPA designated FEM TAPI T640 replaced the SHARP monitor and was designated as the primary $PM_{2.5}$ monitor beginning in 2019. At the end of 2018 monitoring with the FRM ceased. This is the only $PM_{2.5}$ monitor in Sussex County.

Figure 27: $PM_{2.5}$ Pollution Rose - Seaford

Wind data source: Georgetown Delaware Coastal Airport, NOAA LCD



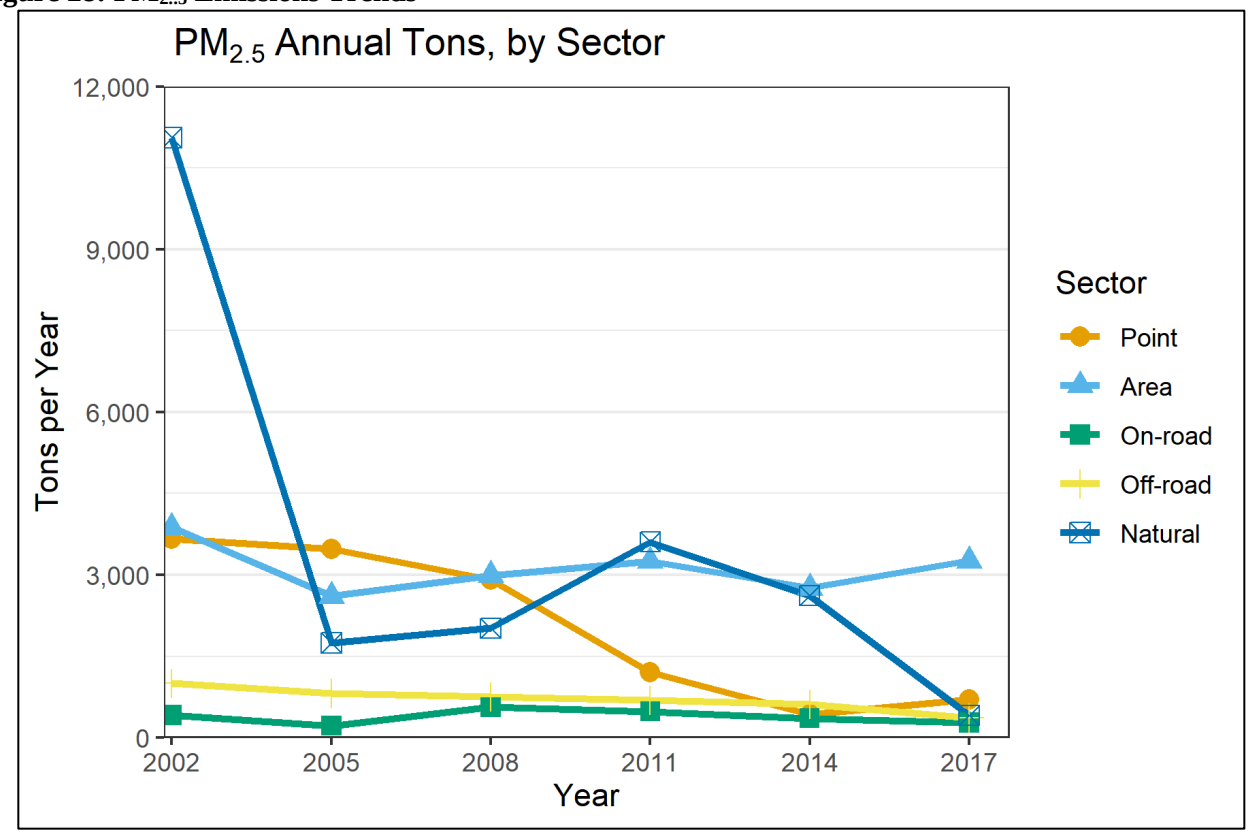
High hourly $PM_{2.5}$ concentrations show limited directionality; however winds are most frequently from the southwest and northeast. More frequent instances of elevated $PM_{2.5}$ with occur from the southwest.

Emissions info/maps

Trends – Statewide from 2017 National Emissions Inventory
Emissions in most categories have trended downward, which correlates with the improvements in ambient $PM_{2.5}$ levels as seen in the following section.

More information on the National Emissions Inventory including data is available from the EPA's NEI page.

Figure 28: $PM_{2.5}$ Emissions Trends

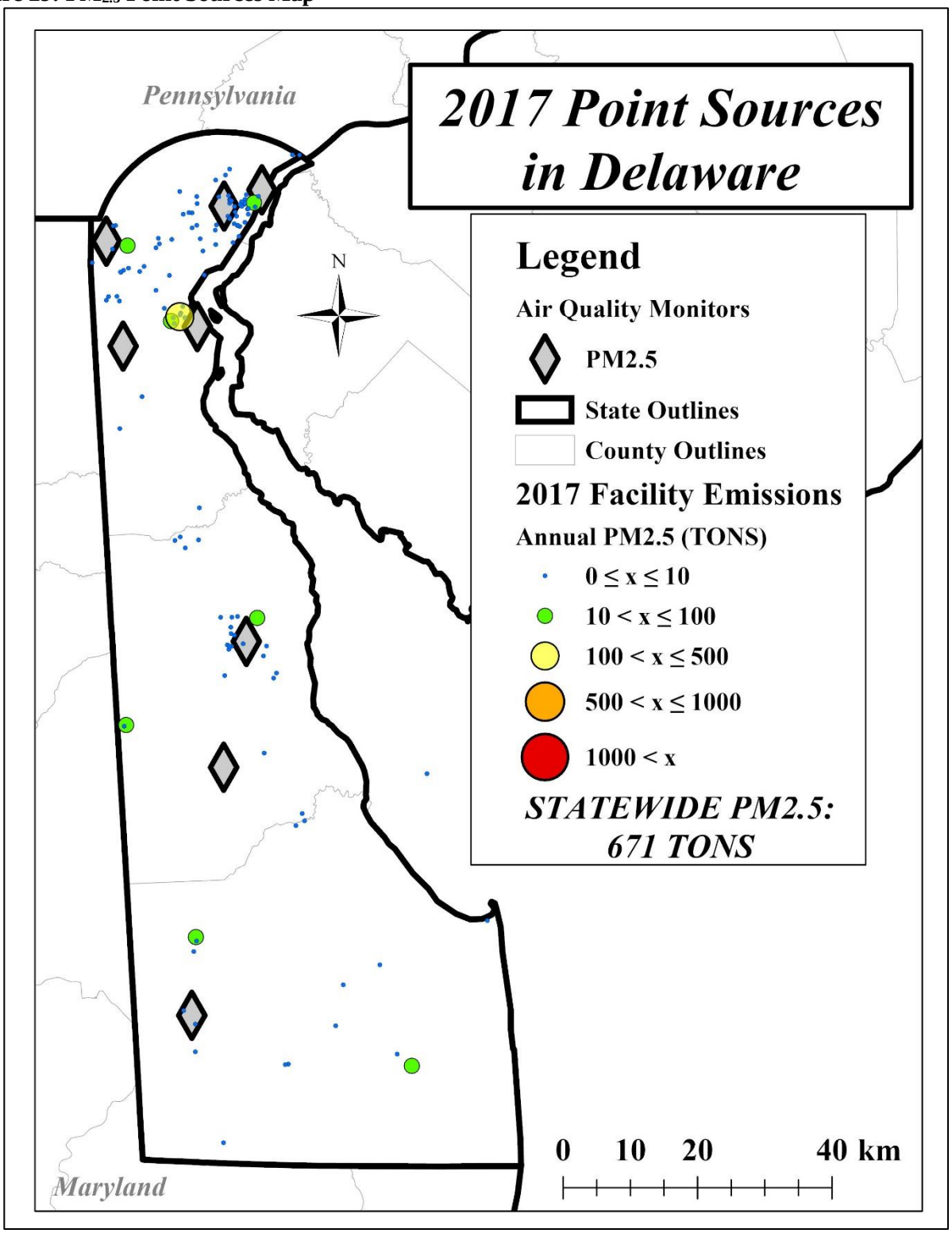


Maps - Point Sources and Contribution
Top 5 $PM_{2.5}$ Facilities from the most recent National Emissions Inventory (2017).

- Delaware City Refinery
- Hay Road Energy Center
- Indian River Generating Station
- Garrison Energy Center
- Perdue Farms - Bridgeville

The largest $PM_{2.5}$ point sources in Delaware are the Delaware City Refinery, power plants, and industrial boilers. A point source map with $PM_{2.5}$ monitors indicated as pins included on the following page.

Figure 29: $PM_{2.5}$ Point Sources Map



Statistical Analysis

The trends in annual average concentrations at all sites in Delaware have been downward since monitoring began in 1999.

Figure 30: $PM_{2.5}$ Annual Avg, Design Value Trends

3 Year Annual Average ($\mu g/m^3$)

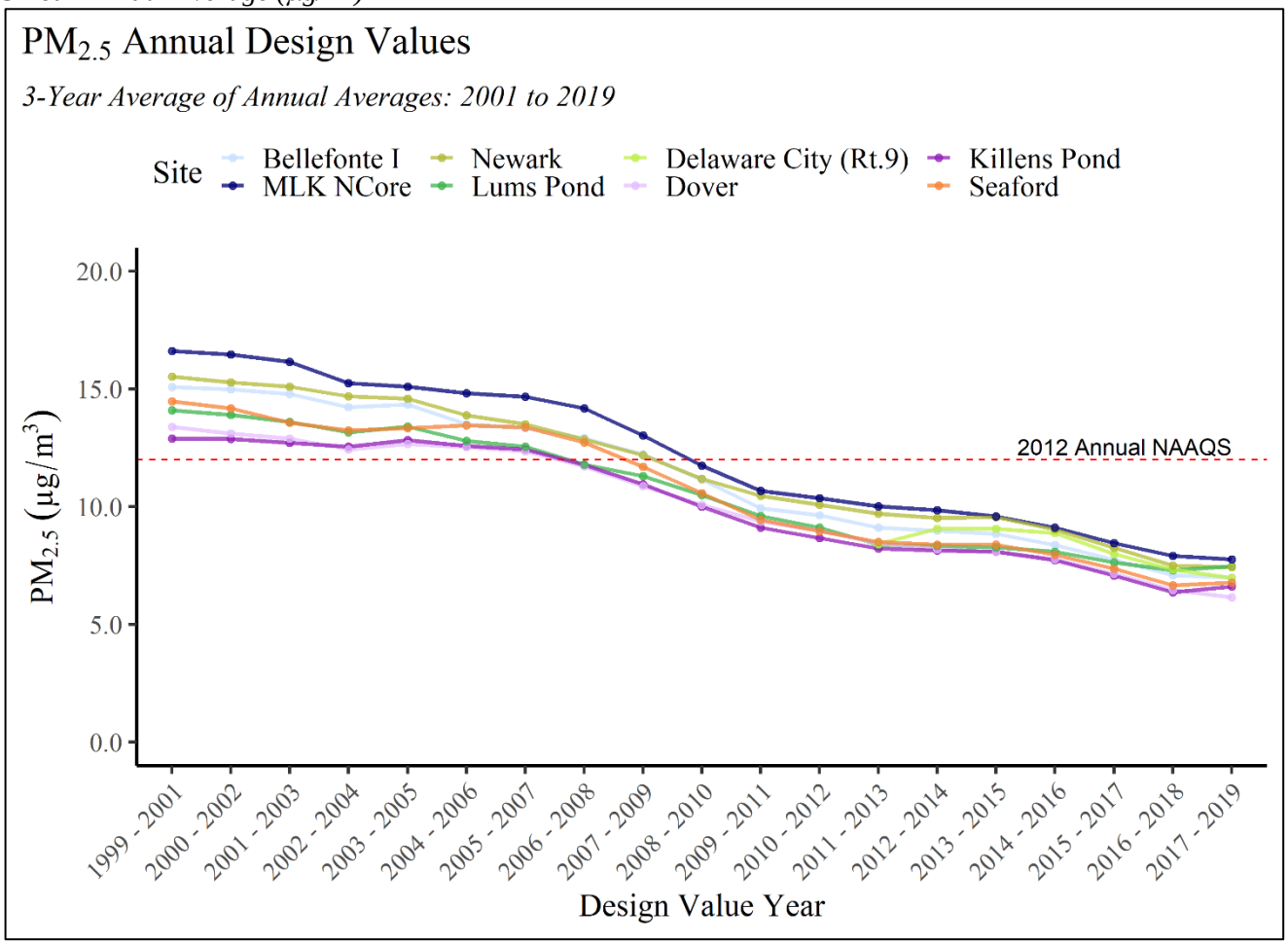


Table 17: $PM_{2.5}$ Annual Avg. Design Value by Site

3 Year Annual Average ($\mu g/m^3$) Design Values

Notes: Design Value Year is the second indicated year, 2000-2002 is DV Year 2002 & includes 2000, 2001, & 2002. 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

5-Year Assessment	Years	Bellefonte I	MLK	Rt. 9	Newark	Lums Pond	Dover	Killens Pond	Seaford
2010	1999-2001	15.1	16.6		15.5*	14.1	13.4	12.9	14.5
	2000-2002	15.0	16.5		15.3	13.9	13.1	12.9	14.2
	2001-2003	14.8	16.2		15.1	13.6	12.9	12.7	13.6
	2002-2004	14.2	15.3		14.7	13.2	12.4	12.6	13.3
	2003-2005	14.3	15.1		14.6	13.4	12.7	12.8	13.4
	2004-2006	13.5	14.8		13.9	12.8	12.5	12.6	13.5
	2005-2007	13.4	14.7		13.5	12.6	12.4	12.4	13.4
	2006-2008	12.9	14.2		12.9	11.8	11.7	11.8	12.7
	2007-2009	12.2	13		12.2	11.3	10.9	11.0	11.7
2015	2008-2010	11.2	11.7		11.2	10.5	10.1	10.0	10.6
	2009-2011	9.9	10.7		10.5	9.6	9.4	9.1	9.5
	2010-2012	9.6	10.4		10.1	9.1	9.0	8.7	9.0
	2011-2013	9.1	10	8.4 *	9.7	8.4	8.4	8.2	8.5
	2012-2014	9.0	9.9	9.0 *	9.5	8.3	8.2	8.1	8.4
2020	2013-2015	8.9	9.6	9.0 *	9.6	8.3	8.1	8.1	8.4
	2014-2016	8.3 *	9.1 *	8.8 *	9.0	8.1 *	7.7 *	7.7	8.0
	2015-2017	7.7 *	8.4 *	7.9 *	8.2 *	7.6 *	7.1 *	7.1	7.4
	2016-2018	7.0 *	7.9 *	7.3 *	7.5 *	7.3 *	6.4 *	6.4	6.7
	2017-2019	7.0	7.8	7.0	7.4 *	7.5	6.2	6.6	6.8

* One or more years with less than 75% data completeness

Trends for the 98th percentile 24-hour averages show declining concentrations in recent years, but the trend is not as strong as for the annual average concentrations. All sites show similar improvements in recent years, and current design values are in compliance with the current 35 µg/m^3 NAAQS.

Figure 31: $PM_{2.5}$ 24hr Avg. Design Value Trends
3 Year 98th Percentiles of 24-hour Averages(µg/m^3)

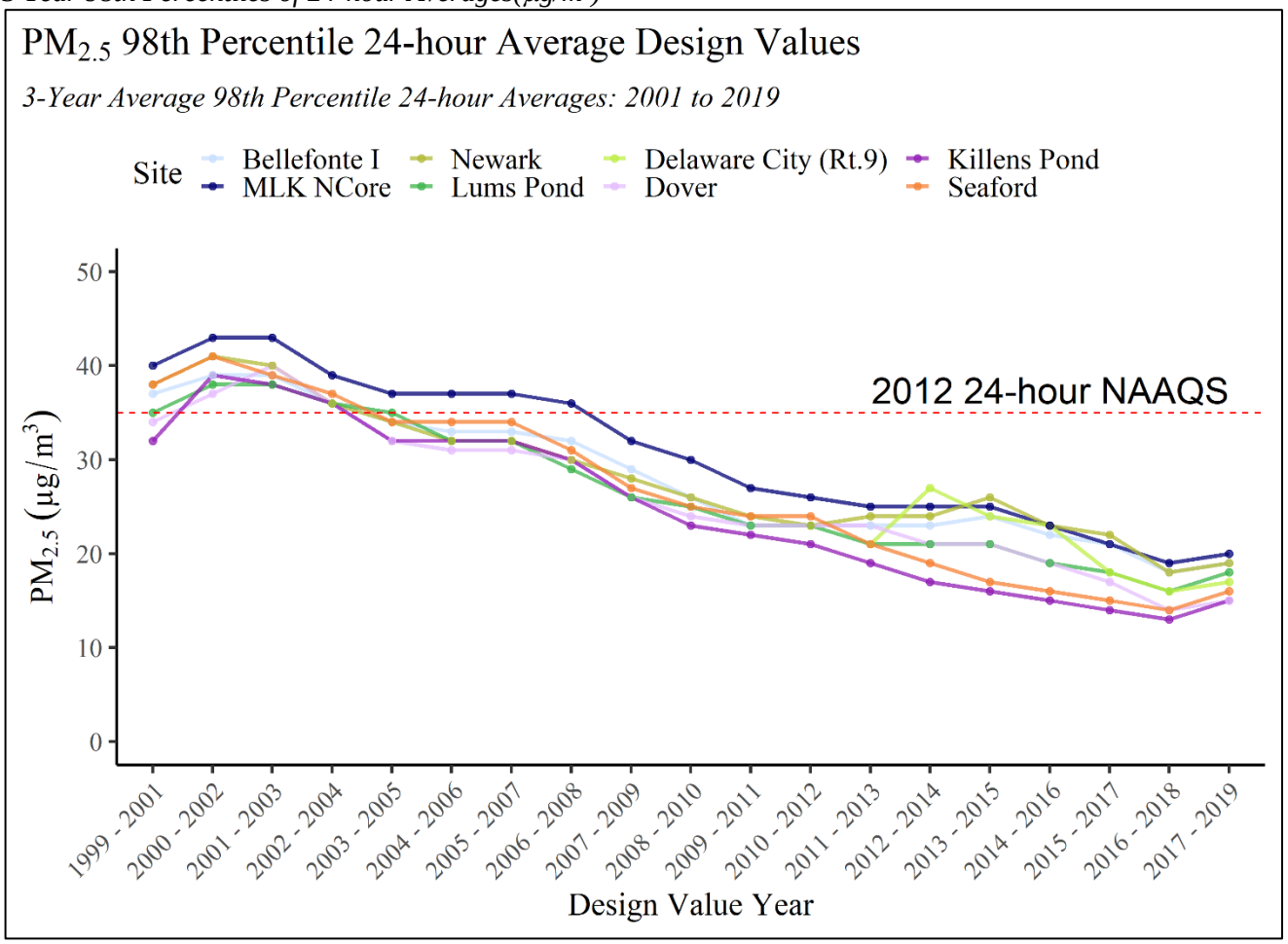


Table 18: $PM_{2.5}$ 24hr Design Values by Site

3 Year 98th Percentile 24-hour Averages ($\mu g/m^3$) Design Values

Notes: Design Value Year is the second indicated year, 2000-2002 is DV Year 2002 & includes 2000, 2001, & 2002. 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

5-Year Assessment	Years	Bellefonte I	MLK	Rt. 9	Newark	Lums Pond	Dover	Killens Pond	Seaford
	1999-2001	37	40		38	35 *	34	32	38
	2000-2002	38	40		38	34	34	35	40
	2001-2003	37	40		36	34	36	34	38
	2002-2004	34	37		33	33	33	33	36
2010	2003-2005	34	37		34	35	32	32	34
	2004-2006	33 *	37		32	32	31	32	34
	2005-2007	33	37		32	32	31	32	34
	2006-2008	31	36		30	29	30	30	31
	2007-2009	29	32		28	26	26	26	27
	2008-2010	26	30		26	25	24	23	25
	2009-2011	23	27		24	23	23	22	24
2015	2010-2012	23	26		23	23	23	22	24
	2011-2013	23	25	21 *	24	21	23	22	23
	2012-2014	23	25	27 *	24	21	21	22	21
	2013-2015	24	25	24 *	26	21	21	16	17
	2014-2016	22 *	23 *	23 *	23	19 *	19 *	15	16
2020	2015-2017	21 *	21 *	18 *	22 *	18 *	17 *	14	15
	2016-2018	18 *	19 *	16 *	18 *	16 *	14 *	13	14
	2017-2019	19	20	17	19 *	18	15	15	16

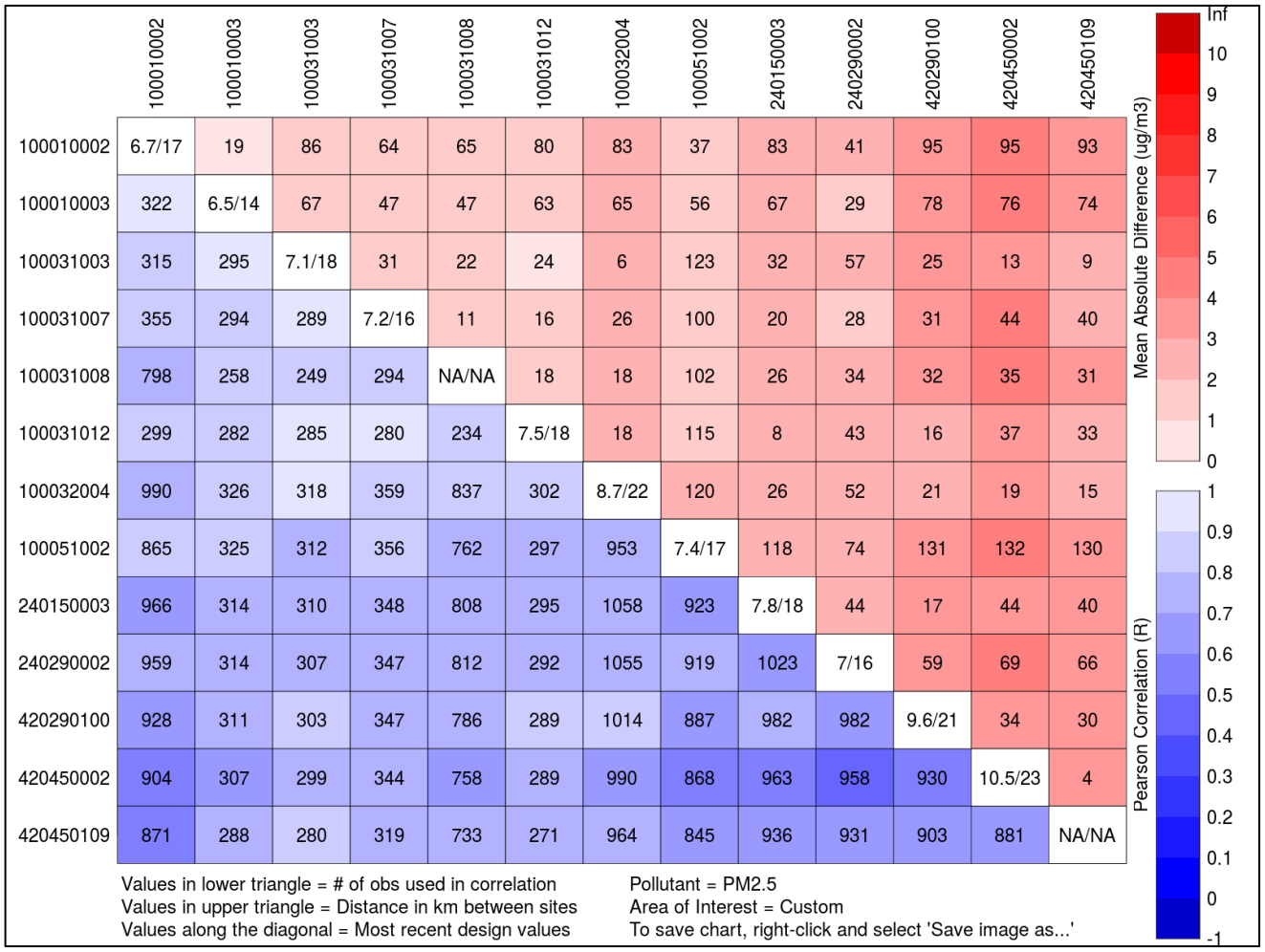
* One or more years with less than 75% data completeness

Correlation Matrix

The Correlation Matrix tool calculates and displays the correlation, relative difference, and distance between pairs of sites within a user selected set of air monitoring sites. Usually, it is expected that correlation between sites will decrease as distance increases. However, for a regional air pollutant, sites in the same air shed can have very similar concentrations and be highly correlated. More unique sites would exhibit the opposite characteristics. They would not be very well correlated with other sites and their relative difference would be higher than other site to site pairs.

Figure 32: NetAssess Correlation Matrix – DE and nearby state $PM_{2.5}$ sites

DV Year 2016 - 2018



	100010002	100010003	100031003	100031007	100031008	100031012	100032004	100051002	240150003	240290002	420290100	420450002	420450109
100010002	6.7/17	19	86	64	65	80	83	37	83	41	95	95	93
100010003	322	6.5/14	67	47	47	63	65	56	67	29	78	76	74
100031003	315	295	7.1/18	31	22	24	6	123	32	57	25	13	9
100031007	355	294	289	7.2/16	11	16	26	100	20	28	31	44	40
100031008	798	258	249	294	NA/NA	18	18	102	26	34	32	35	31
100031012	299	282	285	280	234	7.5/18	18	115	8	43	16	37	33
100032004	990	326	318	359	837	302	8.7/22	120	26	52	21	19	15
100051002	865	325	312	356	762	297	953	7.4/17	118	74	131	132	130
240150003	966	314	310	348	808	295	1058	923	7.8/18	44	17	44	40
240290002	959	314	307	347	812	292	1055	919	1023	7/16	59	69	66
420290100	928	311	303	347	786	289	1014	887	982	982	9.6/21	34	30
420450002	904	307	299	344	758	289	990	868	963	958	930	10.5/23	4
420450109	871	288	280	319	733	271	964	845	936	931	903	881	NA/NA

The sites farthest from each other, as expected, show the lowest correlation and highest average difference. The MLK site had the least correlation with the other sites in Delaware and nearby states. The two sites in Kent County were well correlated with each other ($R^2 > 0.9$) and also with Seaford ($R^2 > 0.9$). The MLK site had the largest number of lower correlations ($R^2 < 0.9$). Looking at sites outside Delaware, there was slightly less correlation (R^2 from 0.7 – 0.9) and somewhat higher average relative difference, again generally increasing with greater distance between the sites.

Table 19: Correlation data (R^2) for $PM_{2.5}$ sites
DV Year 2016 – 2018, State sites shaded

AQS Site ID	10-001-0002	10-001-0003	10-003-1003	10-003-1007	10-003-1008	10-003-1012	10-003-2004	10-005-1002	24-015-0003	24-029-0002	42-029-0100	42-045-0002
10-001-0003	0.94											
10-003-1003	0.85	0.90										
10-003-1007	0.86	0.88	0.92									
10-003-1008	0.78	0.90	0.90	0.89								
10-003-1012	0.82	0.87	0.94	0.93	0.88							
10-003-2004	0.75	0.83	0.91	0.88	0.85	0.89						
10-005-1002	0.83	0.88	0.78	0.82	0.78	0.78	0.74					
24-015-0003	0.62	0.72	0.76	0.77	0.74	0.79	0.75	0.63				
24-029-0002	0.71	0.75	0.72	0.75	0.71	0.75	0.74	0.72	0.67			
42-029-0100	0.66	0.76	0.82	0.79	0.78	0.82	0.81	0.67	0.74	0.66		
42-045-0002	0.53	0.62	0.73	0.75	0.63	0.70	0.64	0.56	0.60	0.48	0.59	
42-045-0109	0.59	0.75	0.84	0.76	0.72	0.78	0.80	0.62	0.66	0.63	0.64	0.62

DE
MD
PA

The sites farthest from each other, as expected, show the lowest correlation and highest average difference. The Seaford site had the least correlation with the other sites in Delaware and Killens Pond had the least with nearby states. The two sites in Kent County were well correlated with each other ($R^2 > 0.9$) and less with Seaford than in 2015 ($R^2 > 0.8$ down from >0.9). Looking at sites outside Delaware, there was significantly less correlation (R^2 from 0.43 – 0.84) and higher average relative difference, again generally increasing with greater distance between the sites.

Some sites showed slightly weaker correlations compared to 2015. Though all sites are stronger than 2010 data, indicating less influence from local sources and more influence due to regional sources and transport.

Table 20: Correlation data - average relative differences for $PM_{2.5}$ sites

DV Year 2016 – 2018, State sites shaded

AQS Site ID	10-001-0002	10-001-0003	10-003-1003	10-003-1007	10-003-1008	10-003-1012	10-003-2004	10-005-1002	24-015-0003	24-029-0002	42-029-0100	42-045-0002
10-001-0003	0.94											
10-003-1003	1.48	1.24								DE		
10-003-1007	1.36	1.20	1.02							MD		
10-003-1008	1.75	1.41	1.32	1.37						PA		
10-003-1012	1.59	1.45	0.87	1.03	1.36							
10-003-2004	2.92	2.97	2.27	2.26	2.36	2.01						
10-005-1002	1.49	1.45	1.79	1.55	1.76	1.79	2.59					
24-015-0003	2.77	2.57	2.32	2.39	2.33	2.06	2.67	2.57				
24-029-0002	2.05	1.93	2.18	1.93	2.10	2.01	2.89	2.12	2.56			
42-029-0100	3.82	3.96	3.20	3.19	3.43	2.87	2.39	3.67	3.31	3.81		
42-045-0002	4.50	4.57	3.79	4.45	4.26	3.60	3.36	4.26	3.87	4.60	3.75	
42-045-0109	3.56	3.25	2.67	2.81	3.19	2.73	2.40	3.17	3.20	3.42	3.39	3.64

Removal bias – A positive average bias would mean that if the site being examined was removed, the neighboring sites would indicate that the estimated concentration would be larger than the measured concentration. Likewise, a negative average bias would suggest that the estimated concentration at the location of the site is smaller than the actual measured concentration. Please refer to the discussion in the Ozone section for detailed information on this EPA statistical method.

Figure 33: NetAssess $PM_{2.5}$ site Removal Bias map output

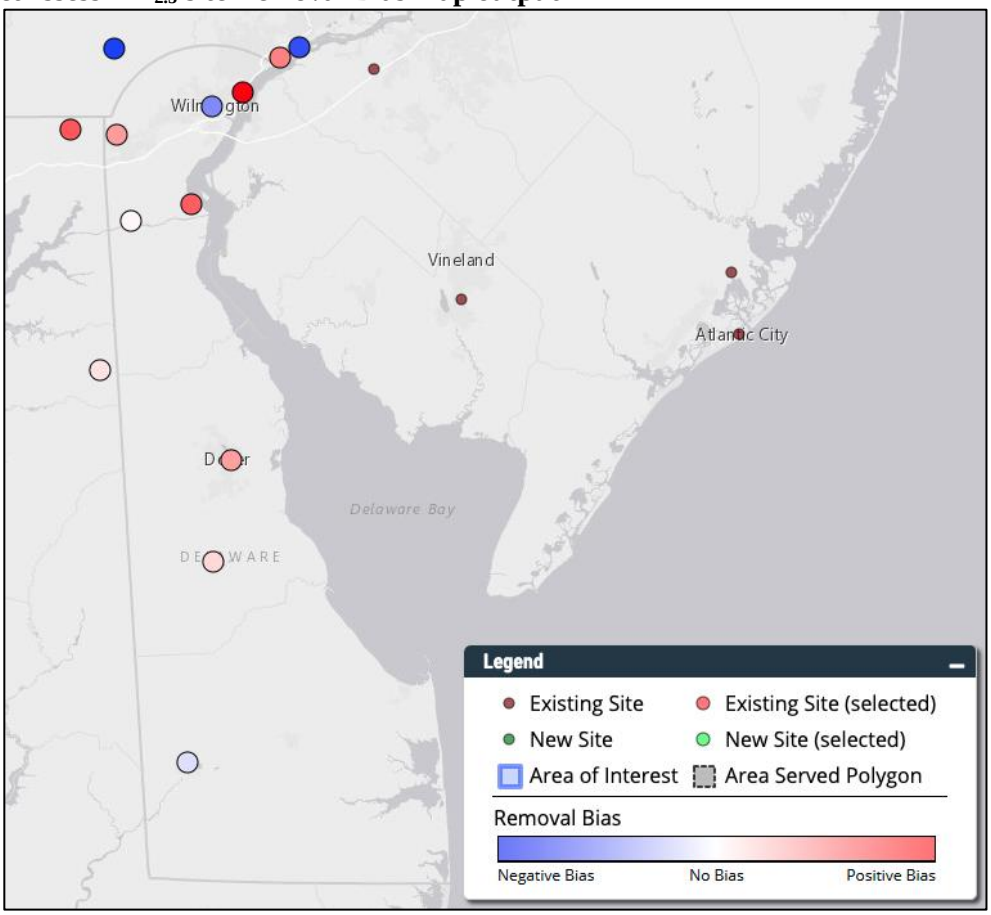


Table 21: NetAssess $PM_{2.5}$ Removal Bias results

AQS ID	Site Name	Mean Removal bias	Removal Bias Standard Deviation	Mean Relative Removal Bias (%)
10-001-0002	Killens Pond	0.28	2	19.2
10-001-0003	Dover	0.69	1.1	16.5
10-003-1003	Bellefonte I	2.08	1.62	34.6
10-003-1007	Lums Pond	0.07	1.58	5.4
10-003-1008	Delaware City (Rt.9)	1.21	2.15	23.7
10-003-1012	Newark	0.73	1.6	17.6
10-003-2004	MLK NCore	-0.89	2.57	-5
10-005-1002	Seaford	-0.23	1.98	3.1

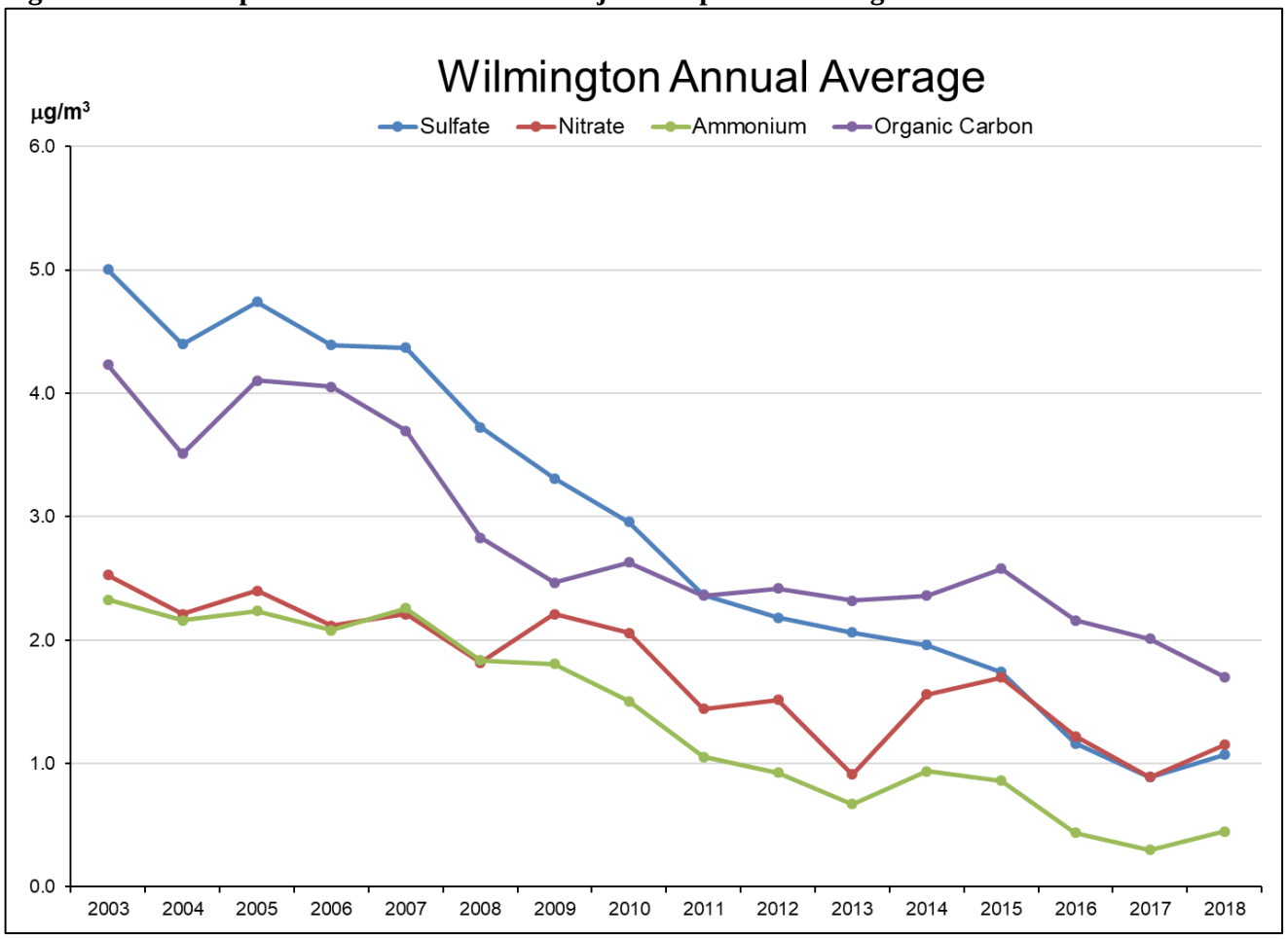
The removal bias analysis indicates that for all $PM_{2.5}$ monitoring sites in Delaware except Lums Pond, a significant bias would be introduced to the design values if any site were removed.

$PM_{2.5}$ speciation

Delaware began operating $PM_{2.5}$ chemical speciation monitors in 2001 at two sites; one at the annual and 98th percentile design value site in Wilmington (MLK) and the other at Dover. The first full year of data was collected in 2002. In 2008 the carbon collection method was changed to the Improve method at MLK; the change occurred at Dover in 2009. The Dover site was discontinued in 2014.

Data from these monitors is used to evaluate $PM_{2.5}$ composition, possible sources impacting concentrations, and evaluation of control measures and trends. Analysis of the data is ongoing, and the most recent validated data available is for 2018.

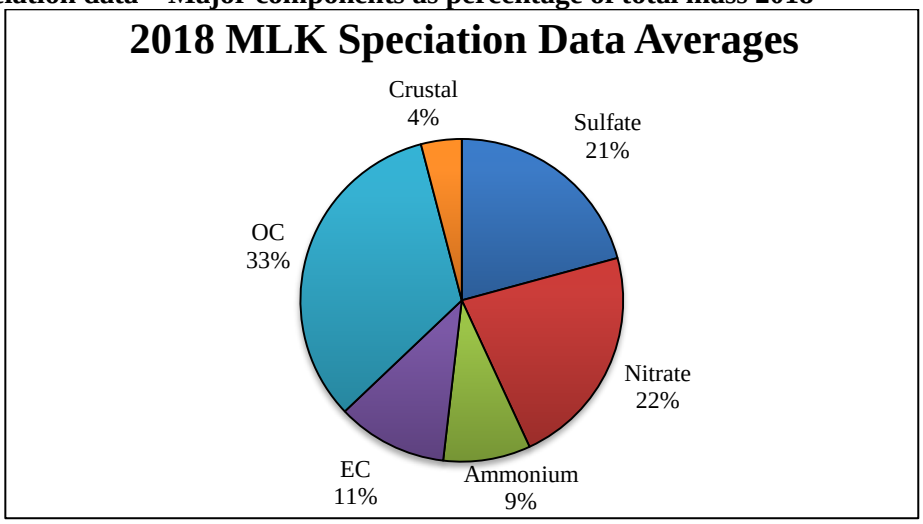
Figure 34: PM2.5 Speciation Trends of Some Major Components through 2018



Analysis of speciation data at MLK shows trends for major components are generally downward or stable; relative composition (major components as percent of total mass) remains similar across all years.

The relative concentrations of the major components shown below are also consistent with data reported for other speciation monitors in the mid-Atlantic region, i.e., sulfate, nitrate, and organic carbon are the largest percentage of total mass.

Figure 35: Speciation data – Major components as percentage of total mass 2018



Other issues

Local community concerns have become more prominent in recent years, particularly with regard to ambient particulate matter concentrations. Examples include the Millsboro area of Sussex County (power plant), the Claymont community in northern Delaware (former steel mill) and the Eden Park area of south Wilmington (multiple point and mobile sources, environmental justice issues). Various special studies using portable samplers have been completed regarding particulate levels in these areas and results show that concentrations of $PM_{2.5}$ are not elevated in these communities compared to the existing network sites.

Many of the local problems appear to be related to larger particulate concentrations (PM_{10} or TSP) or other pollutants, and it is anticipated that local community concerns will continue into the foreseeable future. Without significant expenditure of resources, however, it will not be possible to establish new permanent monitoring sites in these areas. Delaware is exploring alternative methods such as support for community monitoring projects ("bucket brigade" sampling), temporary portable monitoring methods, and encouraging local large point sources to conduct their own monitoring projects.

PM_{10}

Delaware currently operates one PM_{10} monitor at Local Conditions for AQI generation and calculating PM_{coarse} concentrations on a 1-in-3 day basis at the Wilmington MLK NCore site.

Future needs

Future areas of effort include, evaluating the impact of multi-pollutant factors and trends on PM concentrations, and updating the PM emissions inventory. Delaware plans to replace the remaining FRM $PM_{2.5}$ monitors with new continuous FEM TAPI T640s at the stand-alone FRM monitor sites:

- Bellefonte 10-003-1003
- Newark 10-003-1012
- Dover 10-001-0003

Monitors will be replaced when funding becomes available for the stand-alone monitor enclosures, data acquisition systems, and wireless modem communications.

Community assessments and special projects are also anticipated to be important in future PM monitoring efforts. Future activities are dependent on resource availability.

Summary information and monitor rating for $PM_{2.5}$ - critical criteria shown in **bold**

Table 22: $PM_{2.5}$ Monitor Ratings

Site	Data Criteria: % NAAQS, Max Concentration, Longevity, AQI	Statistical Criteria: Measurement Criticality, Uniqueness, Trends	Situational Criteria: Meteorological Pattern, Area Scale, Area Represented, Federal Requirements, Multi-pollutant	Future Needs, Special Considerations: Impact from NAAQS Revisions, Concentration Gradient, Source-impact, Cost, Community	Rating
Bellefonte I	% NAAQS: Below current NAAQS Longevity: Long trend history	Measurement Criticality: **Removal bias**	Meteorological Pattern: Generally downwind of Wilmington	Concentration Gradient: Between Wilmington and Chester, PA	Credible
MLK	% NAAQS: Below current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Measurement Criticality: Removal bias** Uniqueness: Moderate Correlation **Trends: Tracking control strategies**	**Federal Requirement: NCore Site** **Federal Requirement: Speciation Data** Area Represented: Urban site Multi-pollutant: Collocated with multiple parameters	Source impact: Local source impacts Local community concerns	**Critical**
Newark	% NAAQS: Below current NAAQS Longevity: Long trend history	Measurement Criticality: **Removal bias**	Area Represented: Only monitor in Newark area	Single pollutant site Concentration Gradient: Gradient between Wilmington, DE and Fair Hill, MD	Credible
Lums Pond	% NAAQS: Below current NAAQS Longevity: Long trend history AQI Calculated	Measurement Criticality: Minimal Removal bias	**Federal Requirement: Background/Transport Site, Collocation requirement for $PM_{2.5}$ FRM and FEM monitors**		**Critical**
Delaware City	% NAAQS: Below current NAAQS AQI Calculated	**Measurement Criticality: Removal bias**	Point-source impacted site	Point-source impacted site	Credible
Dover	% NAAQS: Below current NAAQS Longevity: Long trend history **Max Concentration: Design Value**	**Measurement Criticality: Removal bias** Uniqueness: Moderate Correlation	**Area represented: Represents Dover MSA**		**Critical**
Killens Pond	% NAAQS: Below current NAAQS Longevity: Long trend history AQI Calculated	**Measurement Criticality: Removal bias** Uniqueness: Moderate Correlation	**Federal Requirement: Rural Background Site**		**Critical**
Seaford	% NAAQS: Below current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Measurement Criticality: Removal bias** Uniqueness: Moderate Correlation	**Area Represented: Only Site in Sussex County**	Future emissions decrease for Millsboro source Local community concerns	**Critical**

Carbon Monoxide (CO)

Current CO sites

CO is not a high priority pollutant monitored in Delaware because ambient concentrations are well below the NAAQS. Monitoring objectives for CO include trends tracking, AQI generation, and emission control strategy tracking.

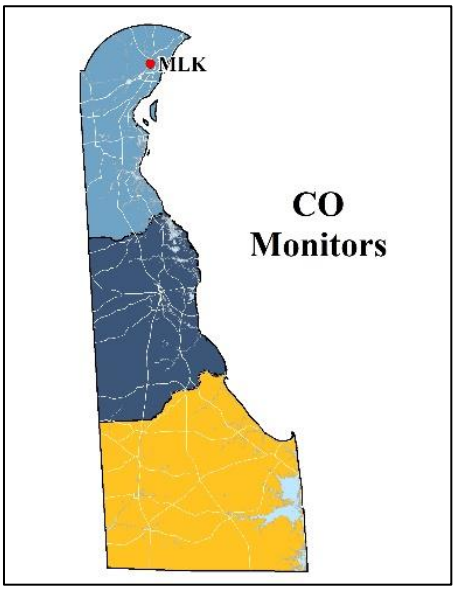


Figure 36: DE CO Monitor Map

Monitoring Requirements

There are no minimum requirements for the number of CO monitoring sites in Delaware. Continued operation of existing CO sites is required until discontinuation is approved by the EPA Regional Administrator. Where CO monitoring is ongoing, at least one site must be a maximum concentration site for that area under investigation.

Delaware formerly operated two CO monitoring sites year-round, with a trace level monitor at the MLK site and a legacy (non-trace) monitor at the Delaware City site. Due to continuous maintenance problems with aging equipment at the Delaware City site, monitoring at that location was discontinued at the end of 2014. Ambient concentrations at the remaining sites in 2019 were well below the NAAQS and close to the minimum detectable limit of the monitor.

Delaware currently operates one CO monitoring site in New Castle County; monitor operates year-round.

Table 23: Delaware CO Monitoring Sites

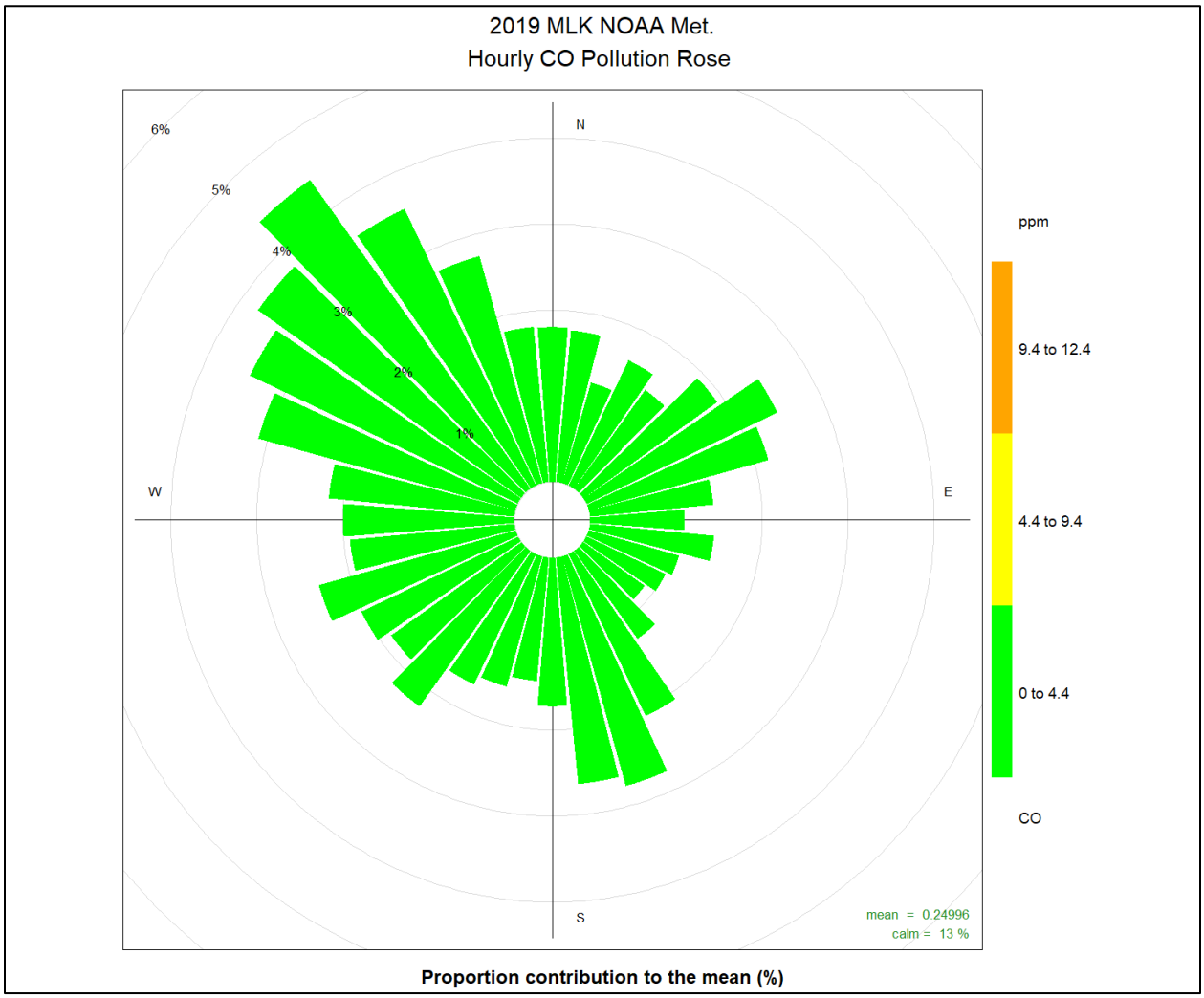
Site	County/MSA	Objectives and Site Type
MLK	New Castle Wilmington division of Philadelphia CSA	NAAQS compliance NCore trace monitoring Max. concentration Trends AQI

Situational analyses

New Castle County sites and characteristics

MLK (10-003-2004) The MLK site was established in 1999 at the intersection of Justison St. and MLK Blvd in Wilmington. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years. The MLK site is middle scale for CO and represents an urban mobile-source dominated site representative of the urban Wilmington core; the primary monitoring objective is maximum concentrations. The site meets all EPA siting criteria. Trace CO monitoring began in 2009 and continued as an NCore requirement.

Figure 37: CO Pollution Rose – MLK NCore (Wilmington)
Met Data Source: Wilmington New Castle County Airport, NOAA LCD



In general, high CO concentrations occur during calm periods and periods with low wind speeds; higher concentrations of CO can be associated with any wind direction due to the generalized urban area surrounding the monitoring site.

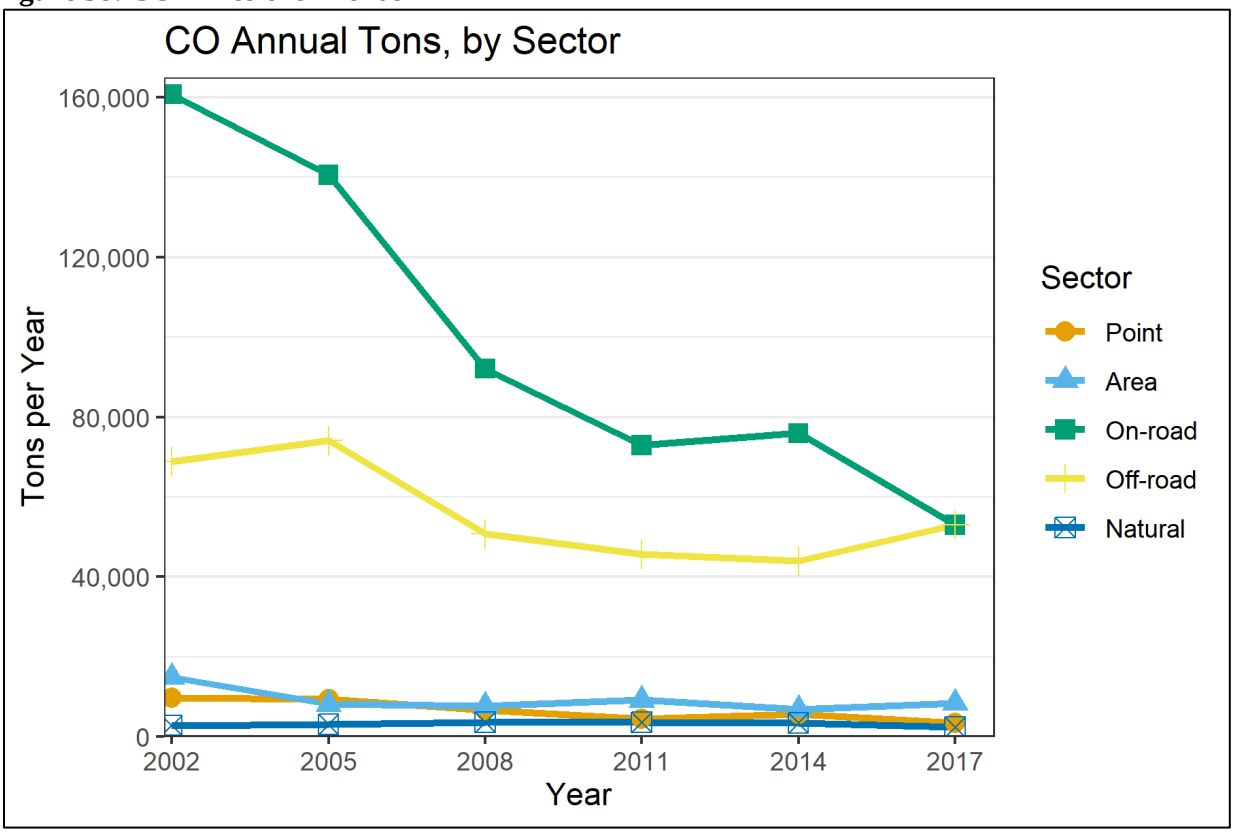
Emissions info/maps

Trends – Statewide from 2017 National Emissions Inventory

Emissions trends have been downward for all source categories. Trends are flatter in recent years, with a slight increase in off-road emissions. Mobiles sources are the largest source category.

More information on the National Emissions Inventory including data is available from the EPA's NEI page.

Figure 38: CO Emissions Trends



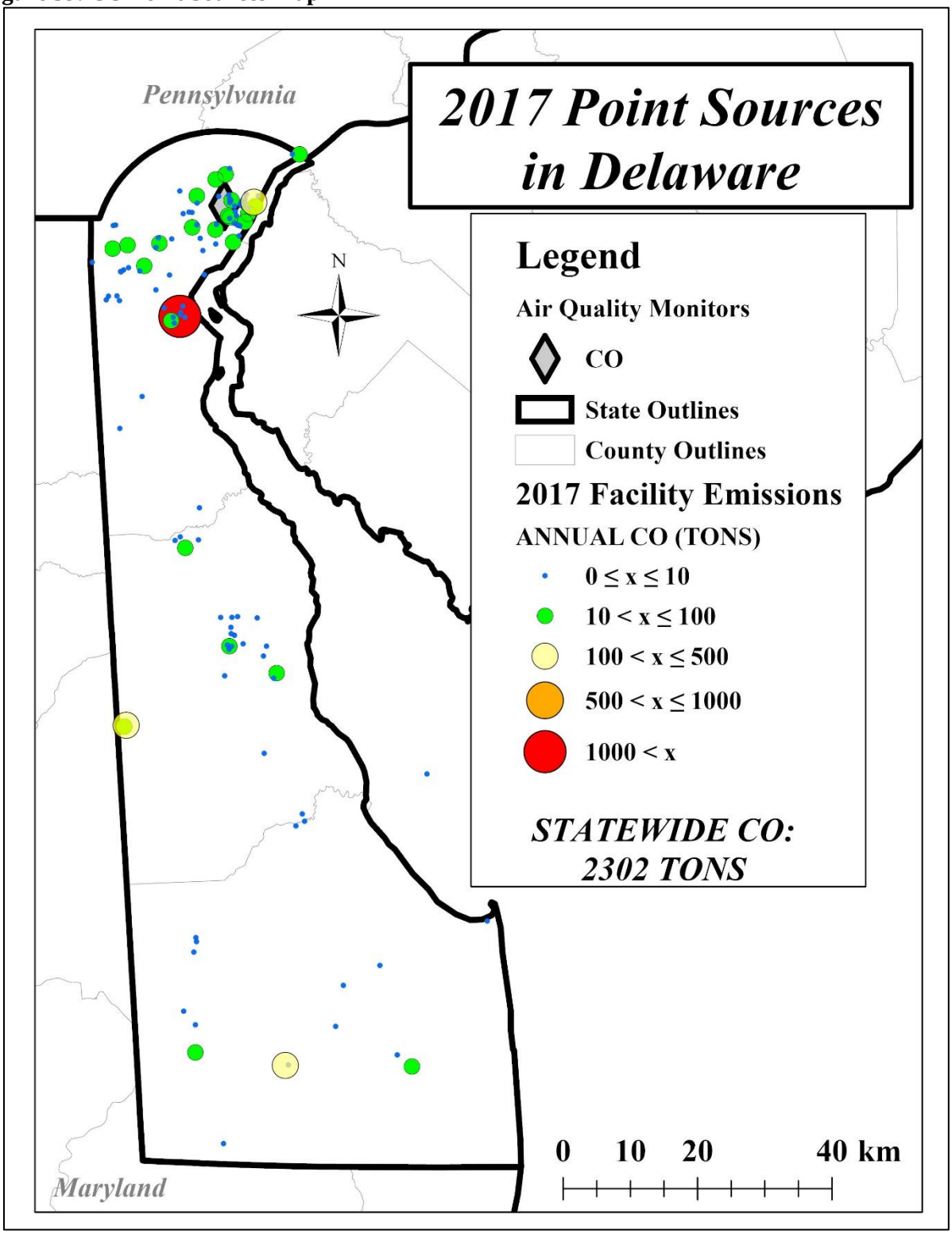
Maps - Point Sources and Contribution

Top 5 CO Facilities from the most recent National Emissions Inventory (2017).

- Delaware City Refinery
- Ameresco Delaware Energy – Southern
- Ameresco Delaware Energy – Central
- Hay Road Energy Center
- DuPont Nutrition USA, Inc

The largest CO point sources in Delaware are power plants, refineries, and industrial boilers; however, the largest source category is mobile sources. The largest point sources are located within New Castle County. Despite the emissions of CO, ambient concentrations remain well below the NAAQS as indicated in the next section.

Figure 39: CO Point Sources Map

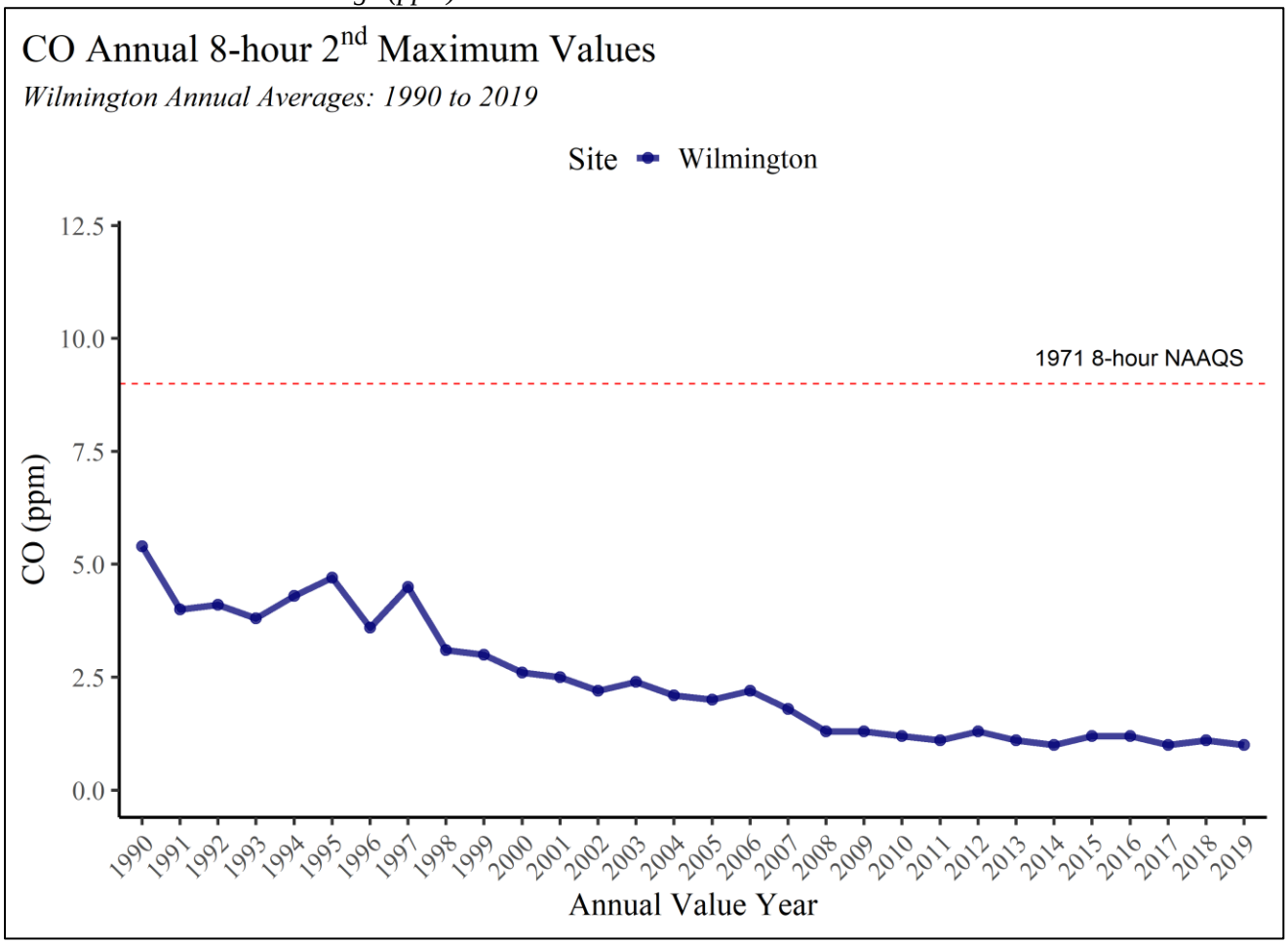


Statistical Analysis

The primary NAAQS for CO are an 8-hour average concentration of 9 ppm and 1- hour average concentration of 35 ppm, which are not to be exceeded more than once per year. The most frequently used design value for CO is the annual second maximum daily 8-hour average.

Figure 40: CO Trends

*Annual 2nd max. 8-hour average (ppm)**



*Wilmington data from 1990 – 1998 is from the 12th & King St. location; after that the data are from the MLK NCore location.

Table 24: CO Annual Values

*Annual 2nd max. 8-hour average (ppm)**

Notes: 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

Year	Wilmington	Year	Wilmington	Year	Wilmington
1990	5.4	2000	2.6	2010	1.2
1991	4.0	2001	2.5	2011	1.1
1992	4.1	2002	2.2	2012	1.1
1993	3.8	2003	2.4	2013	1.1
1994	4.3	2004	2.1	2014	1.0
1995	4.7	2005	2.0	2015	1.2
1996	3.6	2006	2.2	2016	1.2
1997	4.5	2007	1.8	2017	1.0
1998	3.1	2008	1.3	2018	1.1
1999	3.0	2009	1.3	2019	1.0

*Wilmington data from 1990 – 1998 is from the 12th & King St. location; after that the data are from the MLK NCore location.

The trend in annual average concentrations has been downward since monitoring began in 1979. Much of the improvement through the 1990's was related to new motor vehicle emissions standards and technologies; in recent years the air quality has become stable at low concentrations despite continued increase in traffic volume.

Future needs

The existing MLK site is located near major traffic routes in the urban Wilmington area. Since CO maxima occur in areas near major roadways and intersections, this location is considered appropriate for monitoring typical concentrations in urban areas of Wilmington near major roadways.

Summary information and monitor rating for CO - critical criteria shown in **bold**

Table 25: CO Monitor Ratings

Site	Data Criteria: % NAAQS, Max Concentration, Longevity, AQI	Statistical Criteria: Measurement Criticality, Uniqueness, Trends	Situational Criteria: Meteorological Pattern, Area Scale, Area Represented, Federal Requirements, Multi-pollutant	Future Needs, Special Considerations: Impact from NAAQS Revisions, Concentration Gradient, Source-impact, Cost, Community	Rating
MLK	% NAAQS: Below current NAAQS Longevity: Long trend history **Max Concentration: Design Value** AQI Calculated	**Trend: Used for tracking control strategies,** downward trend in concentrations	**Federal Requirement: NCore Site** Multi-pollutant: Collocated with multiple parameters	Local community concerns Source-impact: local & mobile source impacts	**Critical**

Sulfur Dioxide (SO_2)

Current SO_2 sites

Monitoring objectives for SO_2 include NAAQS compliance, trends tracking, AQI generation, and emission control strategy tracking. From the 1970s through the 1990s, SO_2 monitoring was conducted in all three counties in Delaware. Since the mid-1990s, however, due to continuing low ambient concentrations well below the primary and secondary NAAQS and declining resources, monitoring had been restricted to sites in New Castle County where the highest concentrations were being recorded. In 2013 in response to the new SO_2 NAAQS, monitoring began at the Lewes site in Sussex County (see discussion below).

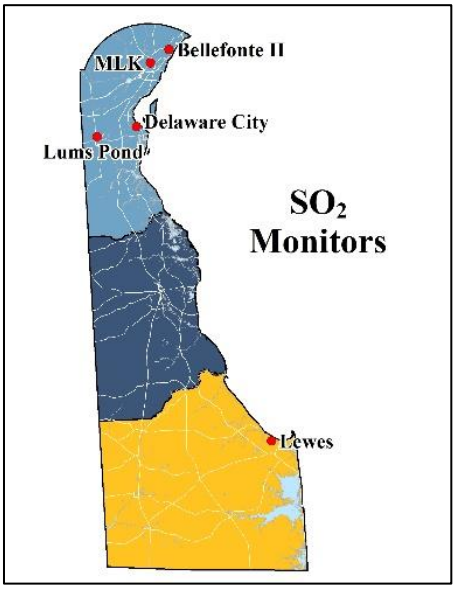


Figure 41: DE SO_2 Monitor Map

Monitoring Requirements

On June 2, 2010, EPA strengthened the primary National Ambient Air Quality Standard (NAAQS) for sulfur dioxide (SO_2). The primary SO_2 standard was revised by establishing a new 1-hour standard at a level of 75 parts per billion (ppb). The new form of the standard is the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations.

EPA also revised the ambient air monitoring requirements for SO_2. For Delaware, the new standard requires one additional monitoring site be established in Sussex County. New monitors needed to meet the network design regulations for the new 1-hour SO_2 standard must have been sited and operational by January 1, 2013 in accordance with the requirements of 40 CFR Part 58 Appendix D and Delaware complied with this requirement by adding a monitor at the Lewes monitoring site in Sussex County to fulfill the requirement for monitoring in the Sussex County portion of the Salisbury metropolitan statistical area (MSA).

EPA also made changes to data reporting requirements for SO_2. State and local agencies are now required to report two data values for every hour of monitoring conducted:

- the 1-hour average SO_2 concentration; and
- the maximum 5-minute block average SO_2 concentration of each hour.

More detailed information on the current SO_2 standards and monitoring requirements can be found on the EPA Historical Table of SO_2 NAAQS website. The most recent NAAQS review in 2019 retained the 2010 standard and form.

Delaware currently operates five SO_2 monitoring sites, four in New Castle County. The fifth site in Sussex County became operational as a SPM in late summer 2012 and a SLAMS on January 1, 2013.

Table 26: Delaware SO_2 Monitoring Sites

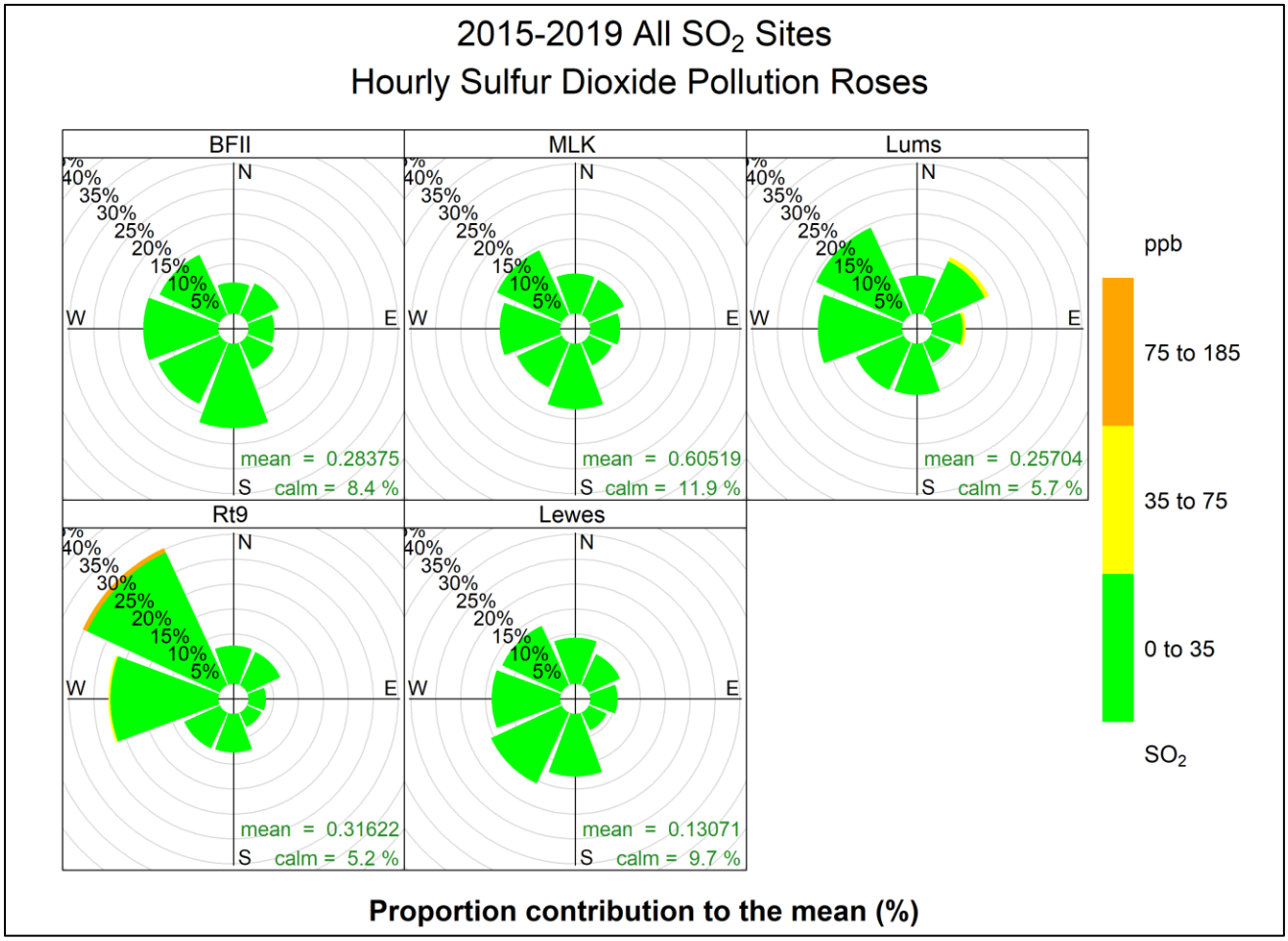
Site	County/MSA	Objectives and Monitor Type
MLK	New Castle Wilmington division of Philadelphia CSA	NAAQS compliance NCore trace monitoring Max. concentration Trends AQI
Bellefonte II	New Castle Wilmington division of Philadelphia CSA	NAAQS compliance Trends
Delaware City (Rt.9)	New Castle Not in MSA	NAAQS compliance Point source impact Trends
Lums Pond	New Castle Not in MSA	NAAQS compliance Trends Background/transport
Lewes	Sussex County Salisbury MD MSA	NAAQS compliance Trends

Situational analyses

Meteorological data for pollution roses was obtained from the NOAA Local Climatological Database (LCD), unless otherwise noted. https://www.ncdc.noaa.gov/cdo-web/datatools/lcd

Hourly SO_2 concentrations show limited directionality and continue to be well below that standard. Exceptions are the Lums Pond and Delaware City sites which are source oriented.

Figure 42: Pollution Roses for All SO_2 Monitoring Sites
2015-2019 Hourly Averages
Wind data source: County Airports, NOAA LCD



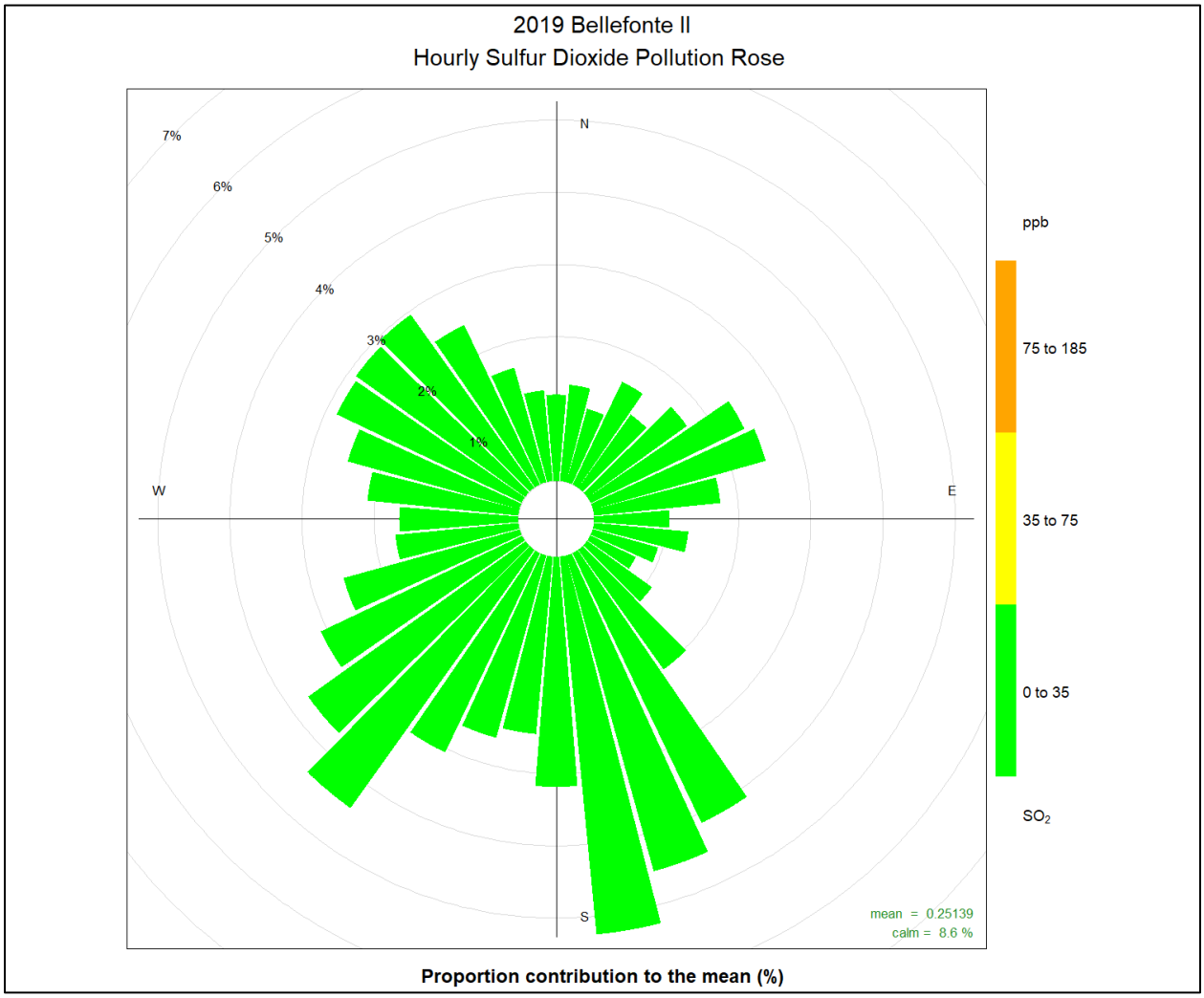
New Castle County sites and characteristics

Bellefonte II (10-003-1013) is the successor site to Bellefonte (10-003-1003). Bellefonte was originally established in 1969 to monitor O_3 and SO_2. When changing site characteristics began to interfere with ozone monitoring, a new site (Bellefonte II) was established in 2001 in Bellevue State Park, less than a mile to the north. The Bellefonte II site meets all EPA siting criteria.

Bellefonte II is neighborhood scale for SO_2, and monitoring objectives are compliance with the NAAQS, population exposures, and trends. Bellefonte II is in the primary downwind direction from Wilmington and is also in a secondary downwind area for a large power plant in the Edgemoor area northeast of Wilmington and the Marcus Hook Industrial Complex, formerly a refinery (Marcus Hook, PA).

Figure 43: SO_2 Pollution Rose – Bellefonte II

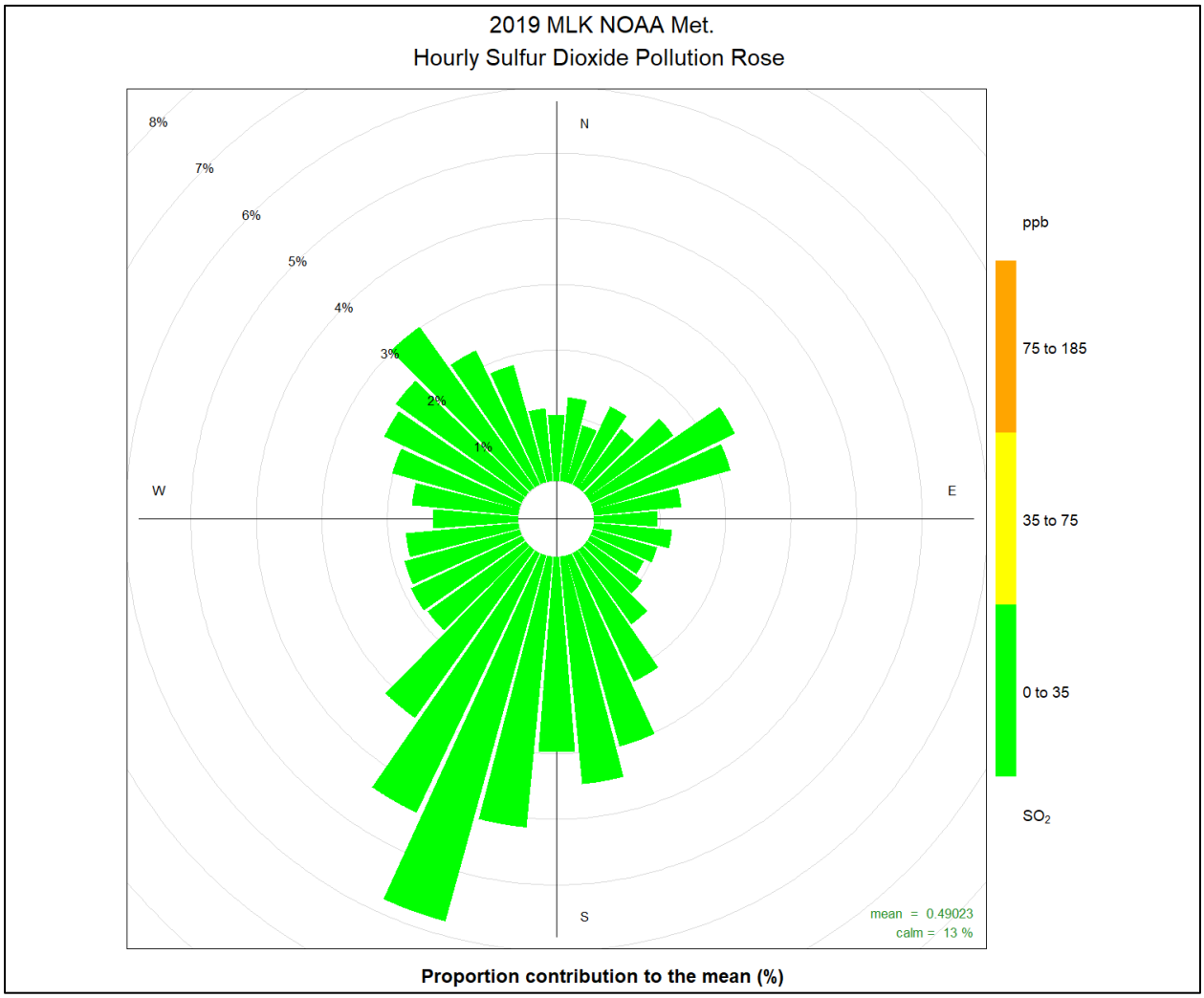
Wind data source: Wilmington New Castle County Airport, NOAA LCD



Low concentrations of SO_2 exhibit limited directionality although more frequently occur in winds with a southerly component.

MLK (10-003-2004) The MLK site was established in 1999 at the intersection of Justison St. and MLK Blvd in Wilmington. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years. The MLK site is neighborhood scale for SO_2 and represents an urban core site impacted by point, area, and mobile sources. The site meets all EPA siting criteria. Trace SO_2 monitoring began in 2009 and continues as an NCore requirement.

Figure 44: SO_2 Pollution Rose – MLK NCore (Wilmington)
Met Data Source: Wilmington New Castle County Airport, NOAA LCD

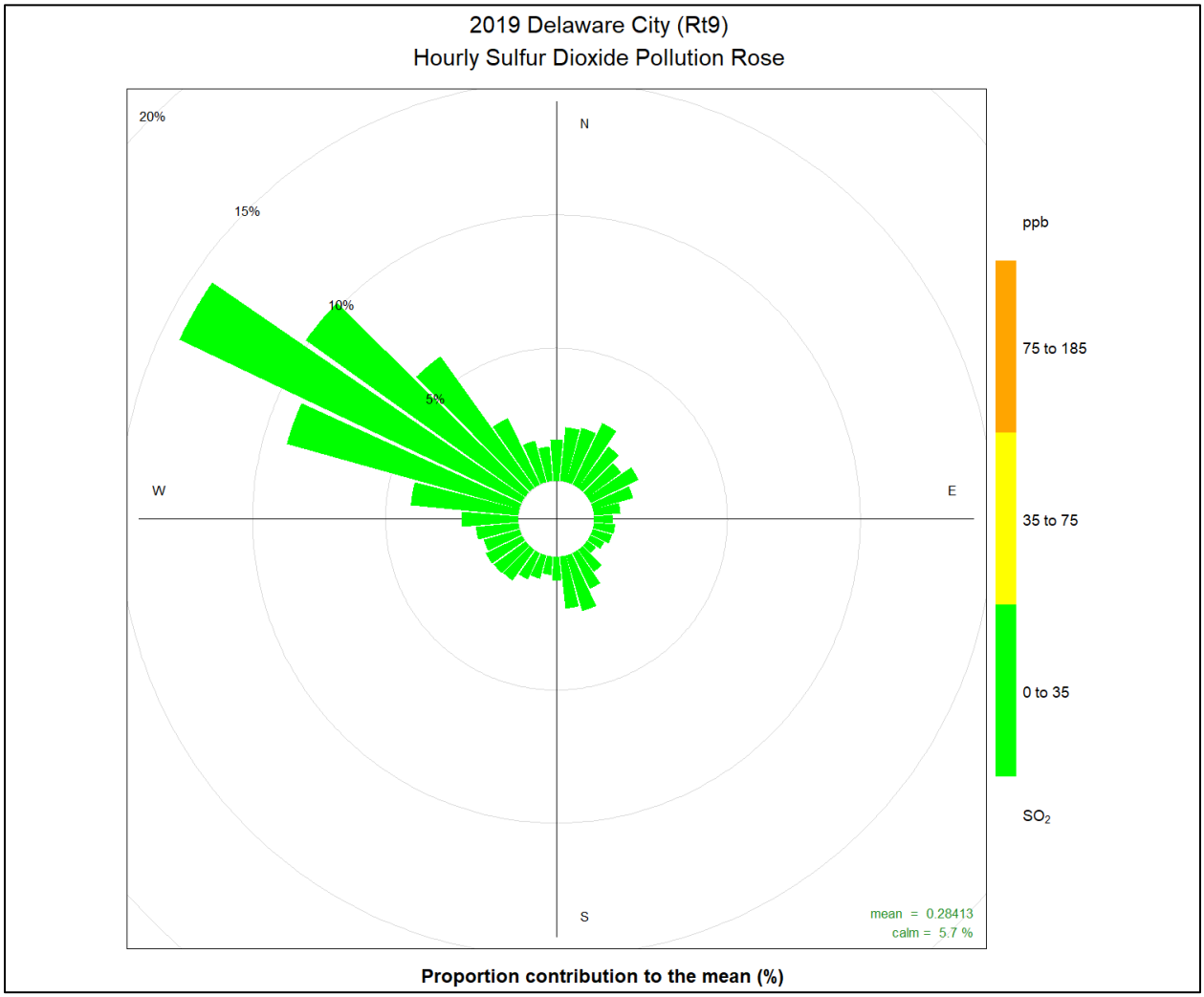


Low concentrations of SO_2 more frequently occur in winds with a southerly component.

Delaware City (10-003-1008) The Delaware City site was established as an SO_2 site in 1992 at a location along Route 9 between the Delaware City industrial complex (including an oil refinery) and the nearest populated area (Delaware City) in the predominant downwind direction. This site replaced an older site a few miles to the southeast (10-003-0006 at the Gov. Bacon Center from 1969 to 1991) in Delaware City.

The current site is neighborhood scale for SO_2 and the primary objectives are point-source impact assessment and population exposure. The site meets all EPA siting criteria.

Figure 45: SO_2 Pollution Rose – Delaware City (Rt. 9)
Met Data Source: Wilmington New Castle County Airport

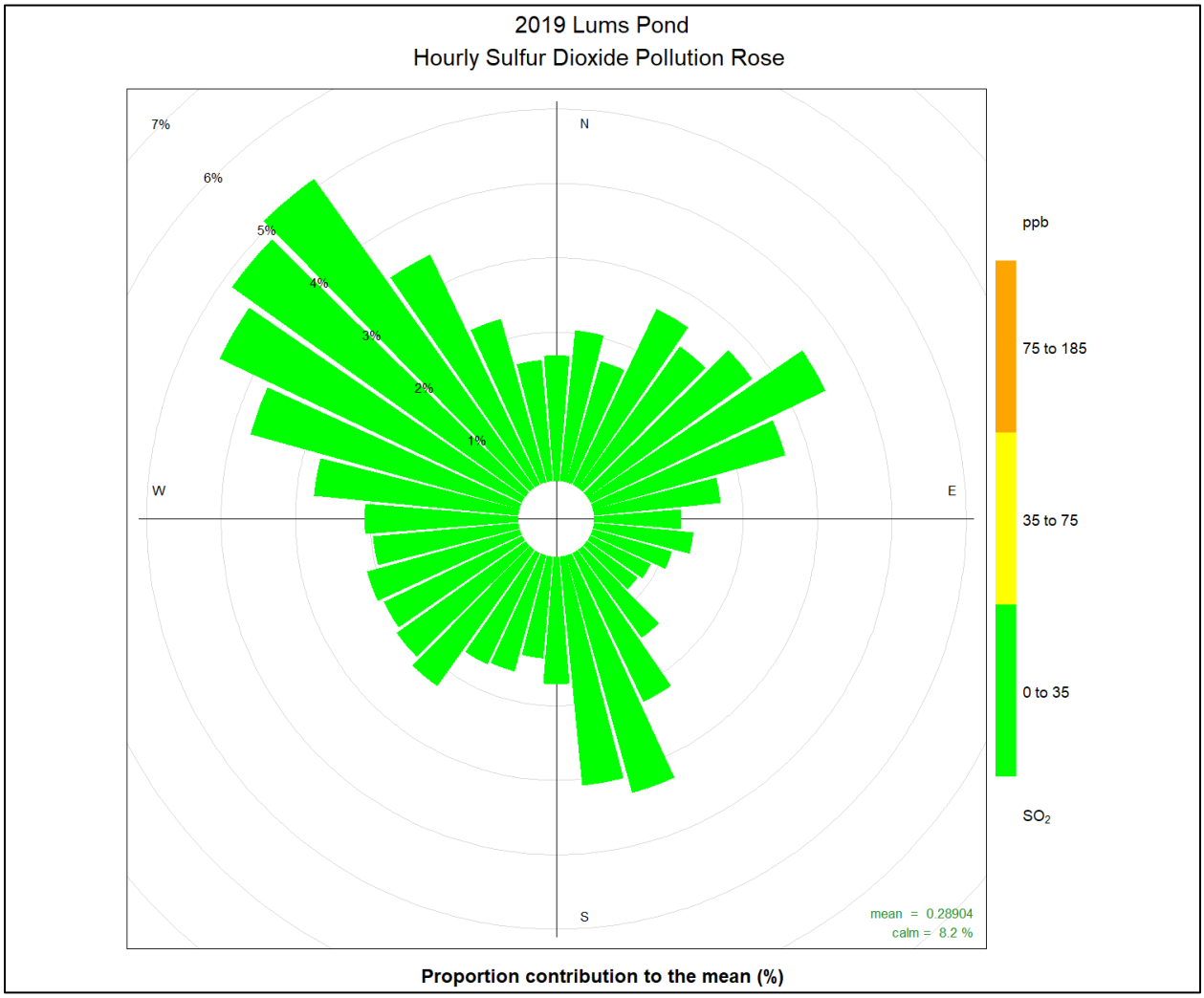


Because this is a source-orientated site, low hourly concentrations of SO_2 more frequently occur in winds from the west/northwesterly direction where the Delaware City Industrial Complex is located.

Lums Pond (10-003-1007). The original Lums Pond site (10-003-0018) was established primarily as an ozone monitoring site in 1981 at Lums Pond State Park. Changes in a nearby park maintenance area caused the site to be moved to a more open area of the park in late 1991, and the new Lums Pond site began reporting data in January 1992. SO_2 monitoring was added in 2001 in response to community concerns about impacts from the oil refinery in Delaware City.

The Lums Pond site is a neighborhood scale site located in a general upwind direction from Wilmington and secondary downwind from the Delaware City area. The site meets all EPA siting criteria.
The objectives and site types are NAAQS compliance, secondary downwind source impact, regional transport, population exposure, and trends.

Figure 46: SO_2 Pollution Rose – Lums Pond
Met Data Source: Wilmington New Castle County Airport

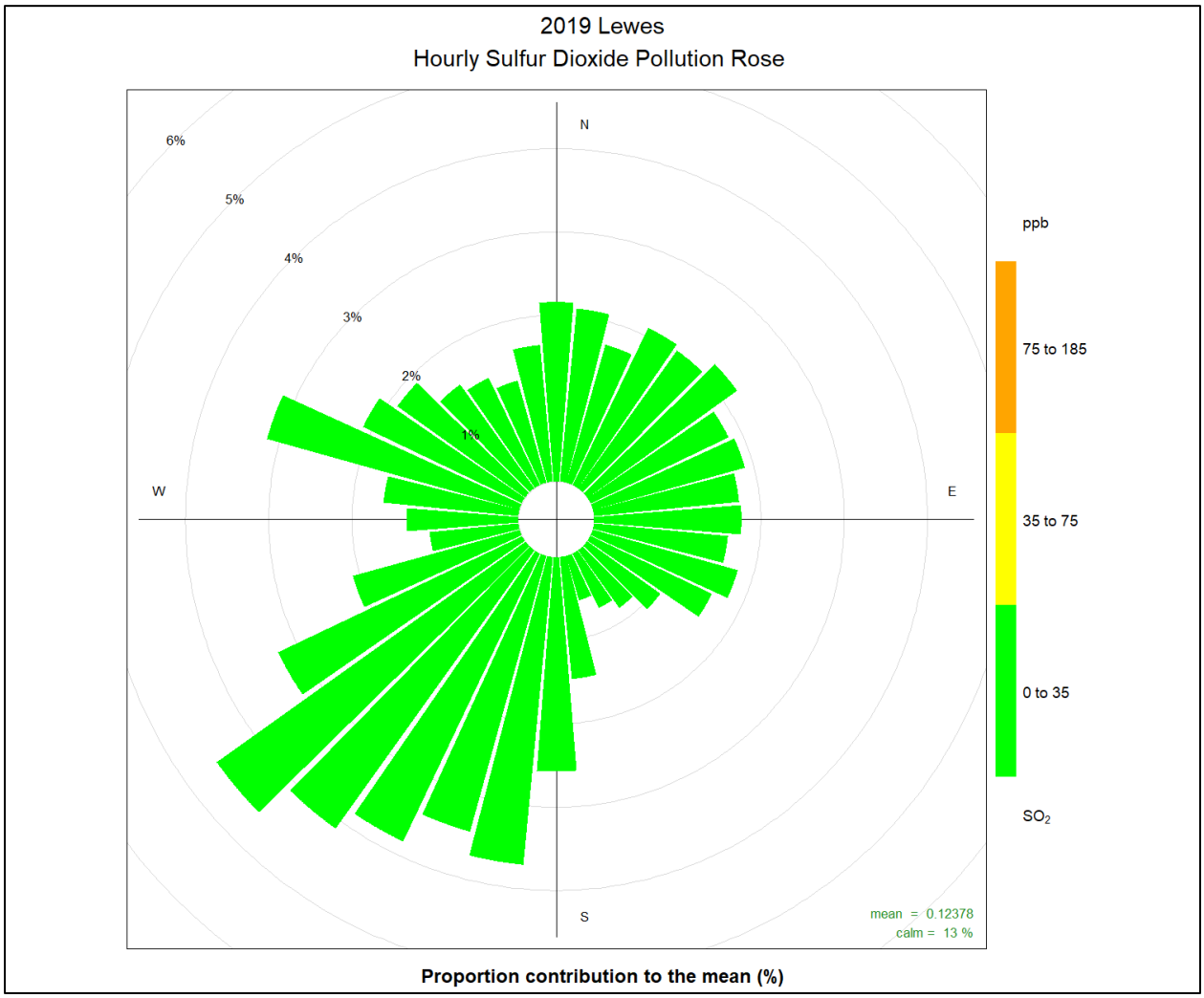


Low concentrations of SO_2 exhibit limited directionality although more frequently occur in winds with a northwesterly component.

Lewes (10-005-1003) The Lewes site was established on the property of the University of Delaware College of Marine Studies campus in 1997. The SO_2 monitor became operational as a SPM in late summer 2012 and was designated as a SLAMS on January 1, 2013.

The site meets all EPA siting criteria. The monitoring objectives include NAAQS compliance, population exposure, and trends.

Figure 47: SO_2 Pollution Rose - Lewes
Wind data source: Georgetown Delaware Coastal Airport, NOAA LCD
**note this is an inland Airport vs a coastal site*



Low concentrations of SO_2 more frequently occur in winds with a southwesterly component.

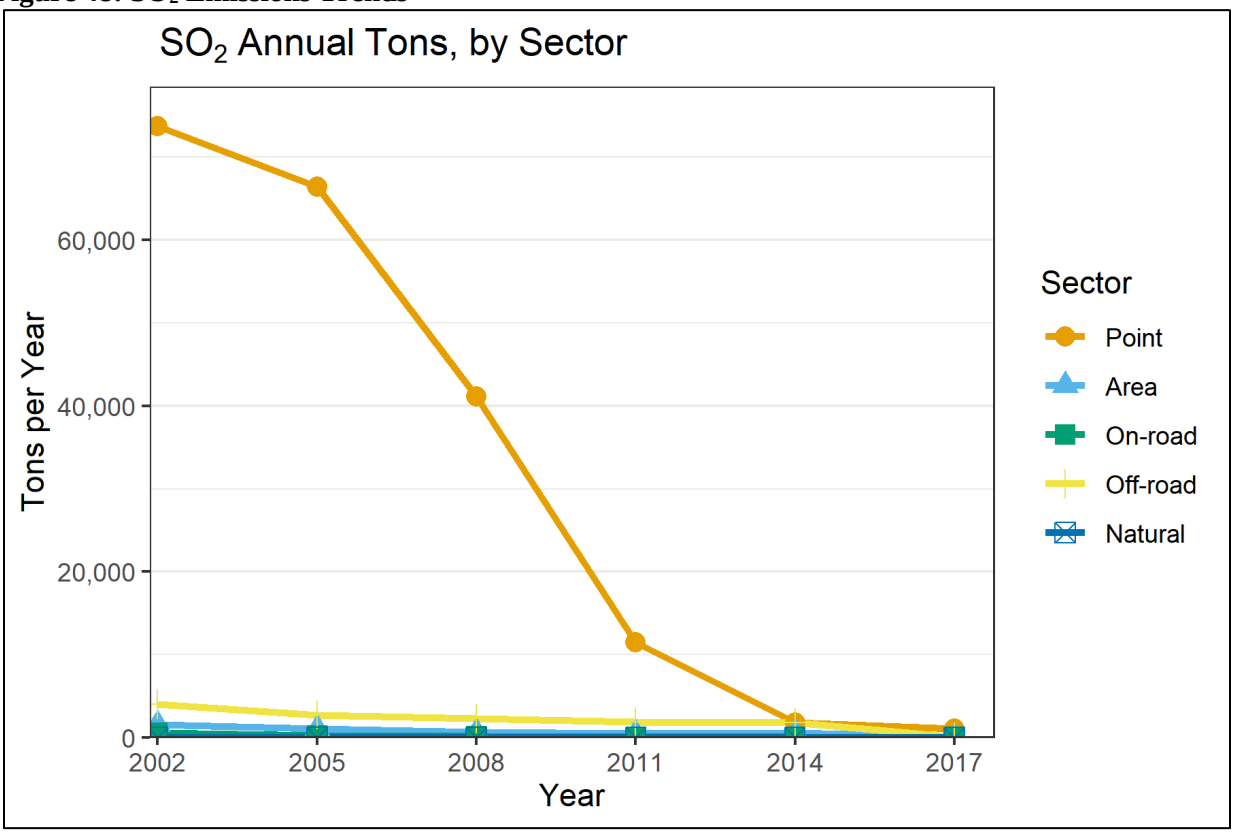
Emissions info/maps

Trends – Statewide from 2017 National Emissions Inventory

Downward trends in point source emissions are largely due to regulatory programs such as the Acid Rain Program, Clean Air Interstate Rule (CAIR), and sulfur in fuel requirements. Recent changes at power plants (emission controls and changes in fuels) continue to result in lower emissions and improvements in ambient concentrations.

More information on the National Emissions Inventory including data is available from the EPA's NEI page.

Figure 48: SO_2 Emissions Trends



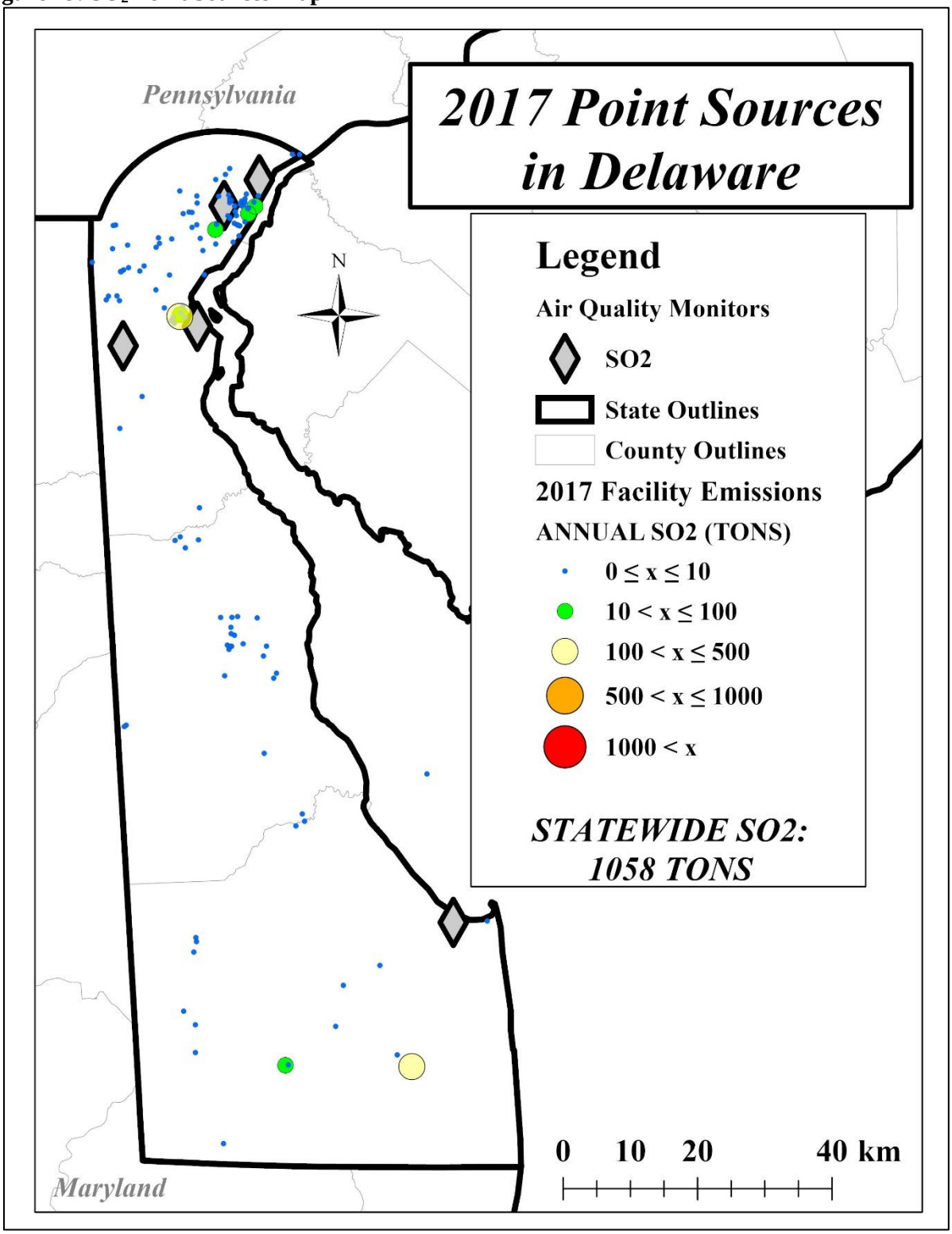
Maps - Point Sources and Contribution

Top 5 SO_2 Facilities from the most recent National Emissions Inventory (2017).

- Indian River Generating Station
- Delaware City Refinery
- Veolia – Red Lion Plant
- Edge Moor Energy Center
- Delaware Recyclable Products, Inc.

The largest SO_2 point sources in Delaware a power plant in Millsboro (Indian River Generating Station) and the Delaware City Refinery. The vast majority of SO_2 emissions are from industrial point sources. A point source map with SO_2 monitors indicated as pins included on the following page.

Figure 49: SO_2 Point Sources Map



Statistical Analysis

The current primary NAAQS for SO_2 is a 1-hour average of 75 ppb calculated as a 3-year average of the 99th percentile 1-hour average. In 2010 EPA revoked the annual average (0.03 ppm) and 24-hour average (0.14 ppm) standards.

The trend in SO_2 concentrations at all sites in Delaware has been downward since monitoring began in the 1960s. Significant improvements in ambient concentrations of SO_2 are due to regulatory programs such as the Acid Rain Program, Tier 2 tailpipe and fuel standards, Clean Air Interstate Rule (CAIR), diesel fuel sulfur standards, and standards for marine diesel engines. The dramatic improvement in the 24-hour averages at the Delaware City monitor between 2006 and 2007 is attributed to the installation of scrubbers at the oil refinery.

Figure 50: SO_2 Design Value Trends
3-year Average 99th Percentile 1-Hour Average (ppb)

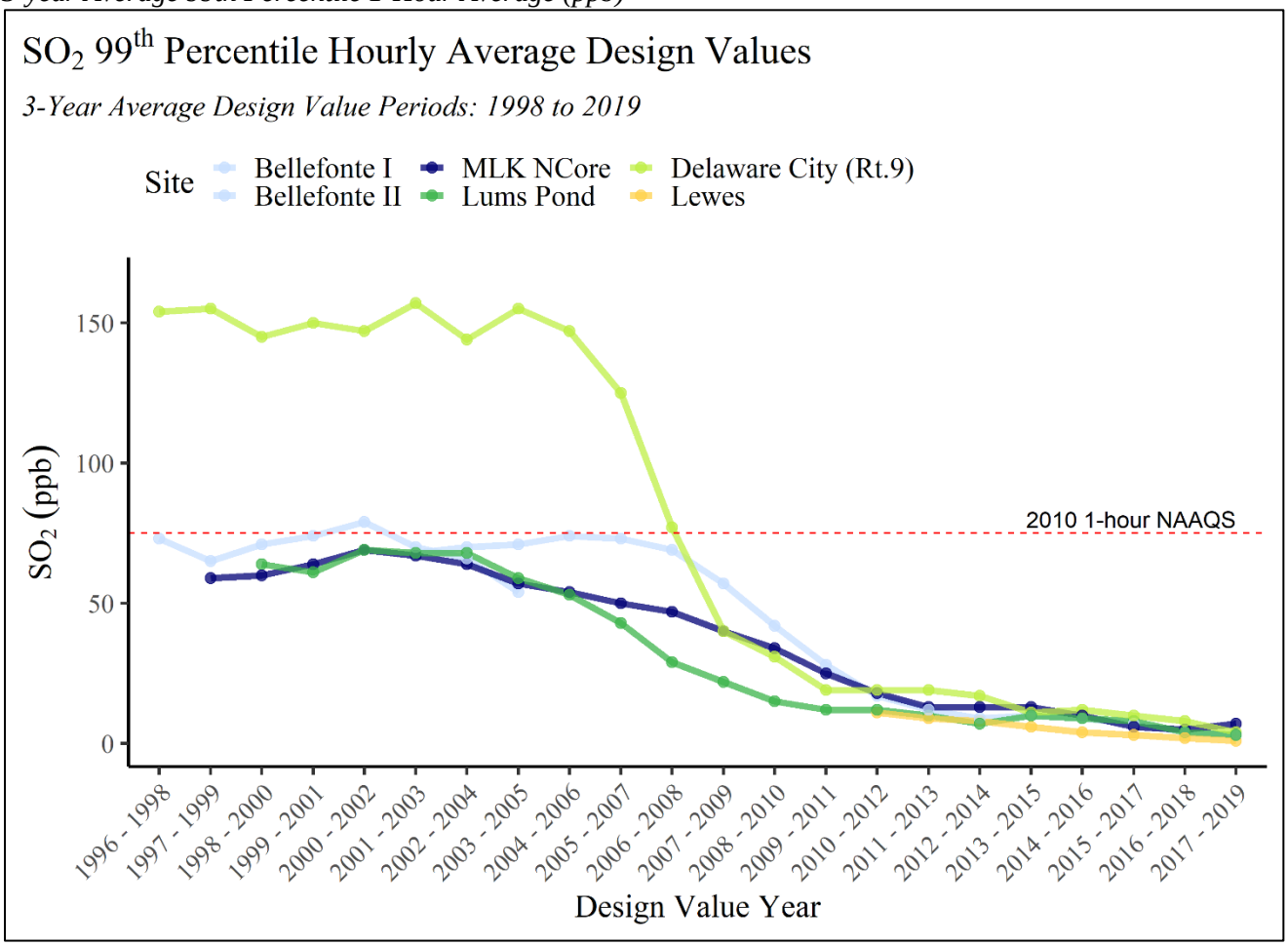


Table 27: SO_2 Design Values by Site

3-year Average 99th Percentile 1-Hour Average (ppb)

Notes: Design Value Year is the second indicated year, 2000-2002 is DV Year 2002 & includes 2000, 2001, & 2002. 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

5-Year Assessment	Year	**Bellefonte I & II	MLK	Delaware City	Lums Pond	Lewes
2010	1998-2000	71	60 *	145	64 *	
	1999-2001	74	64 *	150	61 *	
	2000-2002	79	69	147	69 *	
	2001-2003	70 *	67 *	157	68 *	
	2002-2004	70 *	64 *	144	68 *	
	2003-2005	71 *	57	155	59 *	
	2004-2006	74	54	147	53 *	
	2005-2007	73 *	50	125	43 *	
	2006-2008	69 *	47	77	29 *	
	2007-2009	57 *	40	40	22 *	
2015	2008-2010	42 *	34	31 *	15 *	
	2009-2011	28 *	25	19 *	12 *	
	2010-2012	17 *	18	19 *	12 *	11 *
	2011-2013	12 *	13 *	19 *	10 *	9 *
	2012-2014	9 *	13 *	17	7 *	8 *
2020	2013-2015	10	13 *	11	10 *	6
	2014-2016	9	10	12	9 *	4
	2015-2017	7 *	6	10	8 *	3
	2016-2018	4 *	5	8	4 *	2 *
	2017-2019	3 *	7	4	3 *	1 *

* One or more years with less than 75% data completeness

** Design Value years 2000-2004 Bellefonte I, Remaining Bellefonte II

Future needs

SO_2 Design Values continue to be well below 50% of the NAAQS and in 2019 the EPA retained existing NAAQS Standards. However, source-oriented monitors continue to see periodic high short-term averages.

All of Delaware's SO_2 monitors exceed the recommended 7-year replacement schedule. As funds become available some of these monitors will be replaced, starting with monitors deemed critical.

Summary information and monitor rating for SO_2 - critical criteria shown in **bold**

Table 28: SO_2 Monitor Ratings

Site	Data Criteria: % NAAQS, Max Concentration, Longevity, AQI	Statistical Criteria: Measurement Criticality, Uniqueness, Trends	Situational Criteria: Meteorological Pattern, Area Scale, Area Represented, Federal Requirements, Multi-pollutant	Future Needs, Special Considerations: Impact from NAAQS Revisions, Concentration Gradient, Source-impact, Cost, Community	Rating
Bellefonte II	% NAAQS: Below NAAQS Max Concentration: Between MLK and DE City Longevity: Long trend history AQI: Calculated	Trend: Downward trend	Meteorological Pattern: Secondary downwind for Marcus Hook PA refinery/industrial complex	Community concerns	Credible
MLK	% NAAQS: Below NAAQS Longevity: Long trend history Max Concentration: Highest concentrations in latest DV Year AQI: Calculated	**Trend: Used for tracking control strategies, downward trend**	**Federal Requirement: NCore Site** Area Represented: Urban site Multi-pollutant: Collocated with multiple parameters	Source-impact: Local & mobile source impacts Local community concerns	**Critical**
Route 9 DE City	% NAAQS: Below NAAQS **Max Concentration: Highest short-term average** Longevity: Long trend history AQI Calculated	Trend: Downward trend	**Meteorological Pattern: Downwind major point source**	**Source-impact: Downwind of major SO_2 source**	**Critical**
Lums Pond	% NAAQS: Below NAAQS Max Concentration: Concentrations between levels at Bellefonte and DE City Longevity: Moderate trend history AQI Calculated	Trend: Downward trend	Meteorological Pattern: Secondary downwind direction for DE City oil refinery/industrial complex	Community concerns: West (secondary downwind) of DE City refinery/industrial complex	Credible
Lewes	% NAAQS: Below NAAQS Max Concentration: Lowest concentrations AQI Calculated	Trend: Downward trend	**Federal Requirement – Salisbury MSA**	Design value site for Salisbury MSA	**Critical**

Nitrogen Dioxide (NO_2)

Current NO_2 sites

NO_2 is not currently a high priority pollutant monitored in Delaware because ambient concentrations are well below the NAAQS. There is one NO_2 site in Delaware – the urban Wilmington MLK site. NAAQS revision requiring near-roadway monitoring in the Philadelphia CSA, did not require additional monitors in Delaware.

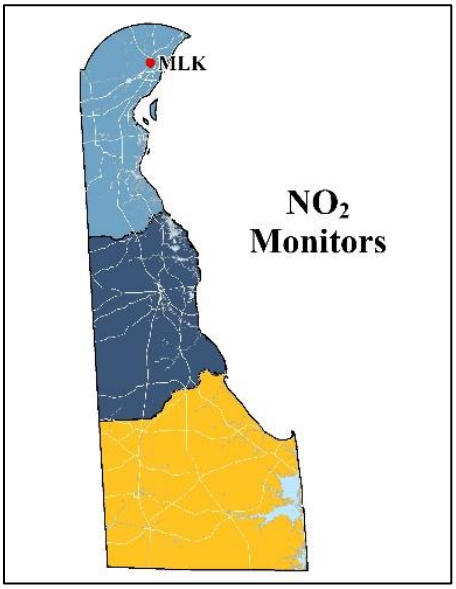


Figure 51: DE NO_2 Monitor Map

Historically, Delaware began NO_2 monitoring at the urban Wilmington site at 12th and King Streets, then at two non-urban sites in New Castle County in the 1990s. The Bellefonte site was a supplemental NO_2 site collocated with an ozone monitor; when the site was relocated to Bellefonte II the NO_2 monitoring was discontinued. The Lums Pond monitor was part of the PAMS program; when the PAMS program ended in 1999, the NO_2 monitor was moved back to the urban Wilmington site.

Monitoring objectives for NO_2 include NAAQS compliance, maximum concentration, population exposure, trends tracking, AQI generation, and emission control strategy tracking.

Monitoring Requirements

On January 22, 2010, EPA strengthened the health-based National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide (NO_2). EPA set a new 1-hour NO_2 standard at the level of 100 parts per billion (ppb). The form for the 1-hour NO_2 standard is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations. EPA also retained, with no change, the current annual average NO_2 standard of 53 ppb.

More detailed information on the new NO_2 standard and monitoring requirements can be found on the EPA Historical Table for NO_2 NAAQS website.

The NCore program requires NOy monitoring at the single NCore site in Delaware (MLK in Wilmington). This monitoring began in 2010.

Table 29: Delaware NO_2 Monitoring Sites

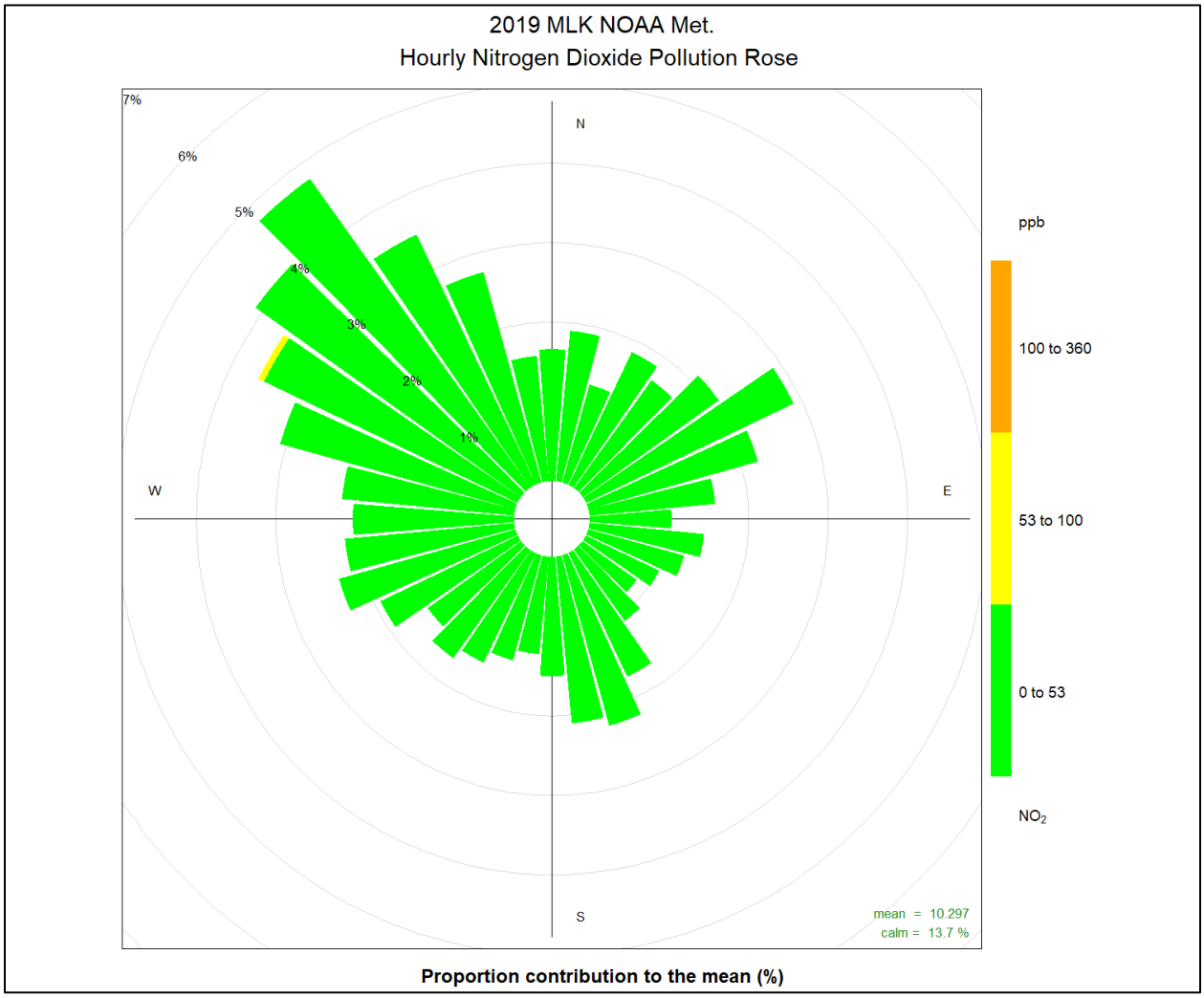
Site	County/MSA	Objectives and Monitor Type
MLK	New Castle Wilmington division of Philadelphia CSA	NAAQS compliance Maximum concentration Population exposure Trends AQI Emissions control strategy tracking

Situational analyses

New Castle County sites and characteristics

MLK (10-003-2004) The MLK site was established in 1999 at the intersection of Justison St. and MLK Blvd in Wilmington. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years. The MLK site is neighborhood scale for NO_2 and represents an urban core site impacted by point, area, and mobile sources. The site meets all EPA siting criteria. NOy monitoring began in 2010 and continues as an NCore requirement.

Figure 52: NO_2 Pollution Rose – MLK NCore (Wilmington)
Met Data Source: Wilmington New Castle County Airport, NOAA LCD



Elevated concentrations of NO_2 can occur with any wind direction; concentrations tend to be highest during calm periods and inversions.

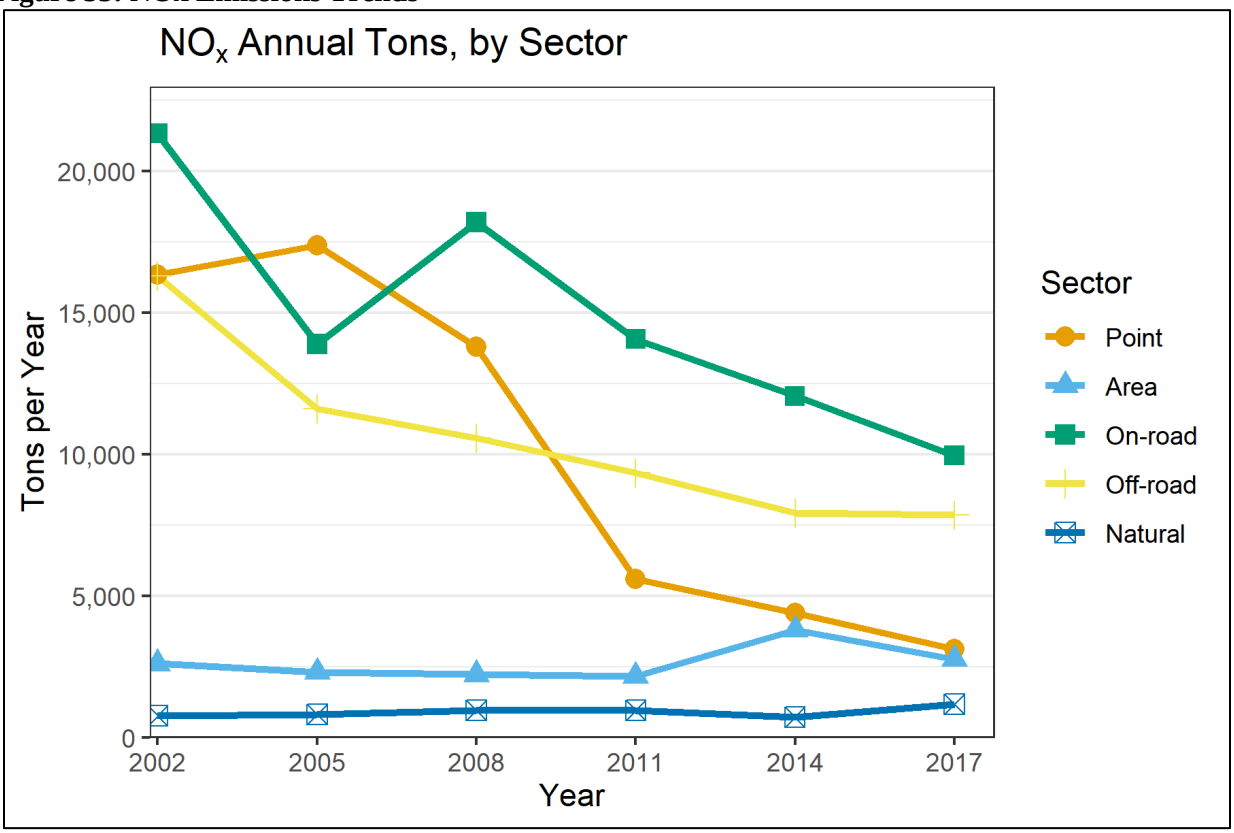
Emissions info/maps

Trends – Statewide from 2017 National Emissions Inventory

Emissions are measured as NOx and not NO_2; NO_2 is formed in the atmosphere but is primarily emitted as NOx. The largest change has been the decrease in point source emissions due to controls on the largest sources. Significant non-point sources include both on and off-road diesel engines. Non-point and mobile sources are a greater percentage of total emissions than point sources.

More information on the National Emissions Inventory including data is available from the EPA's NEI page.

Figure 53: NOx Emissions Trends



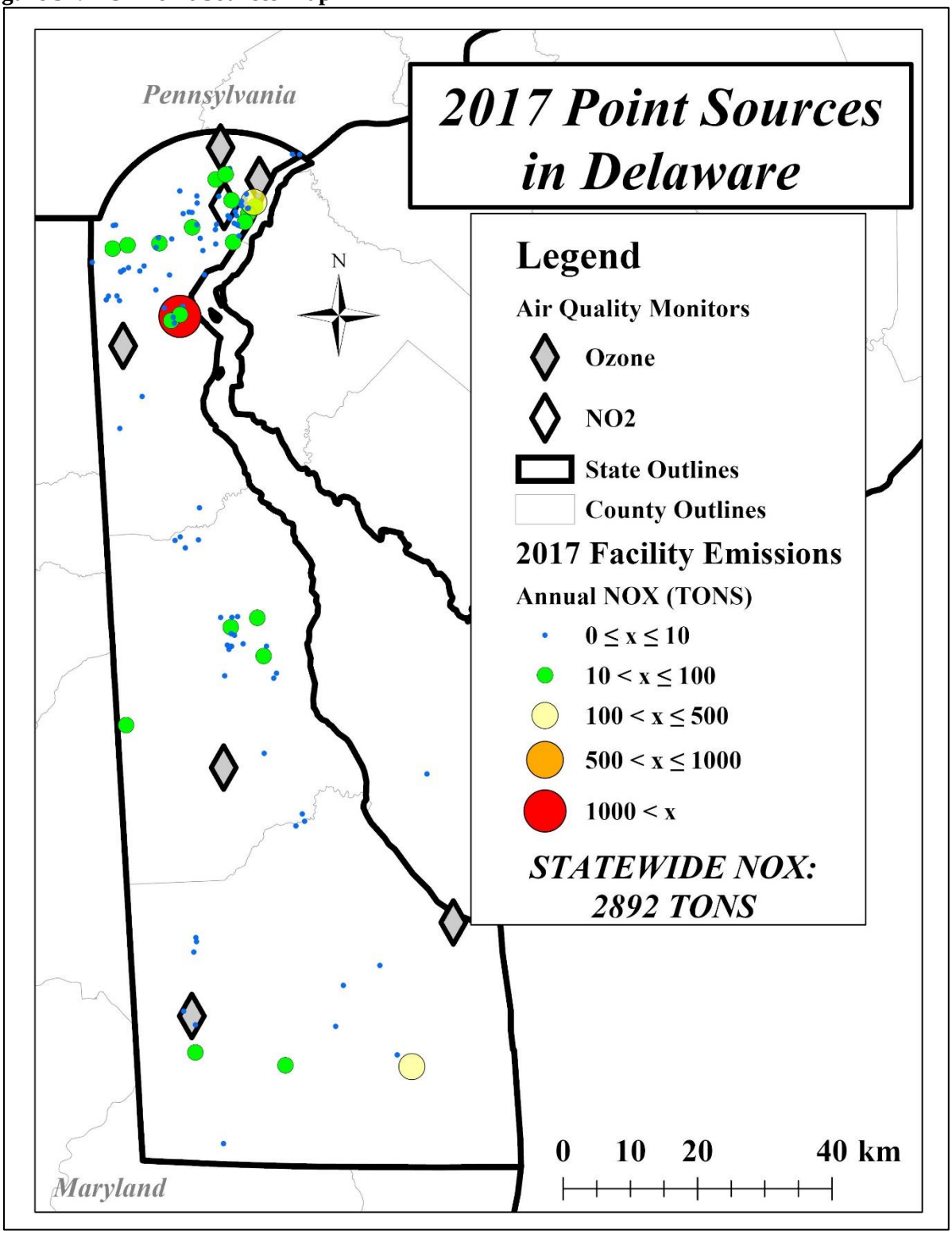
Maps - Point Sources and Contribution

Top 5 NOx Facilities from the most recent National Emissions Inventory (2017).

- Delaware City Refinery
- Hay Road Energy Center
- Indian River Generating Station
- Edge Moor Energy Center
- DuPont Experimental Station

The largest NOx point sources in Delaware include the Delaware City Refinery and power plants in New Castle and Sussex counties. A point source map with Ozone and NO_2 monitors indicated as pins included on the following page.

Figure 54: NOx Point Sources Map



Statistical Analysis

The current primary NAAQS for NO_2 is an annual arithmetic mean of 0.053 ppm (or 53 ppb), and a 1-hour average of 100 ppb as 3-year average of the 98th percentile daily max.

The trend in annual averages has been downward since monitoring began in the 1980s. Improvements in ambient concentrations of NO_2 are due to regulatory programs such as Tier 2 tailpipe and fuel standards. The Tier 2 standards for light-duty vehicles began phasing in in 2004, and new NOx standards for heavy-duty engines were phased in between the 2007 and 2010 model years.

Figure 55: NO_2 Design Value Trends
3-year Average 98th Percentile Daily Max 1-Hour Average (ppb)

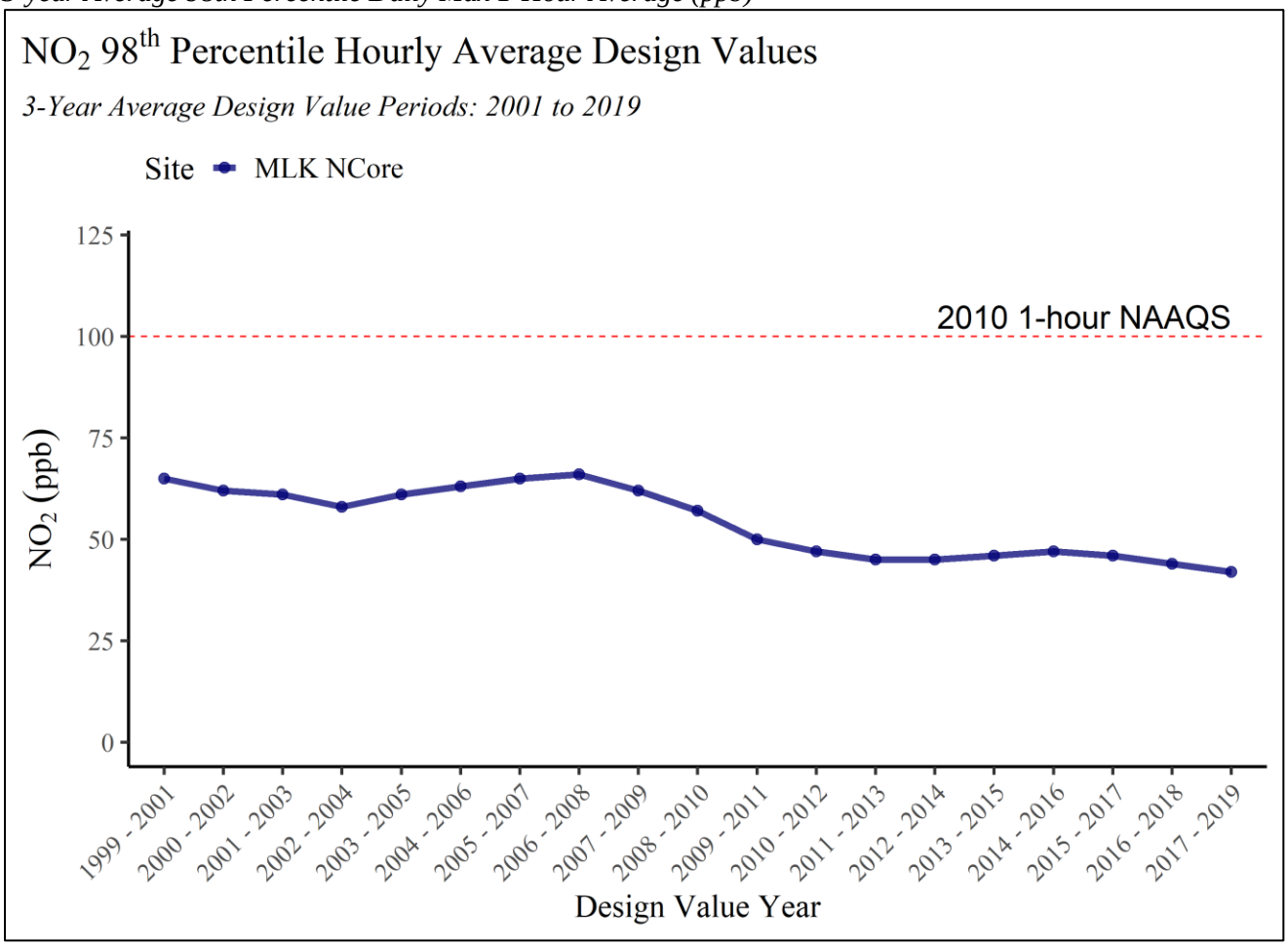


Table 30: NO_2 Design Values

3-year Average 98th Percentile Daily Max 1-Hour Average (ppb)

Notes: Design Value Year is the second indicated year, 2000-2002 is DV Year 2002 & includes 2000, 2001, & 2002. 5-Year Assessments began in 2010, periods shaded to help distinguish changes between assessments.

5-Year Assessment	Years	MLK
2010	2000-2002	62 *
	2001-2003	61 *
	2002-2004	58
	2003-2005	61
	2004-2006	63
	2005-2007	65 *
	2006-2008	66 *
	2007-2009	62 *
2015	2008-2010	57 *
	2009-2011	50 *
	2010-2012	47 *
	2011-2013	45 *
	2012-2014	45 *
2020	2013-2015	46 *
	2014-2016	47 *
	2015-2017	46 *
	2016-2018	44
	2017-2019	42

* One or more years with less than 75% data completeness

Future needs

With the new PAMS Program direct NO_2 monitoring at NCore sites in O_3 nonattainment areas will be required. Delaware is currently testing a monitor that is in trials for FEM designation. Additionally, with implementation of the Enhanced Monitoring Plan (EMP), supplemental monitoring for NOx in the Ozone Transport Region (OTR) will require a NOx analyzer be re-installed at Lewes.

Summary information and monitor rating for NO_2 - critical criteria shown in **bold**

Table 31: NO_2 Monitor Ratings

Site	Data Criteria: % NAAQS, Max Concentration, Longevity, AQI	Statistical Criteria: Measurement Criticality, Uniqueness, Trends	Situational Criteria: Meteorological Pattern, Area Scale, Area Represented, Federal Requirements, Multi-pollutant	Future Needs, Special Considerations: Impact from NAAQS Revisions, Concentration Gradient, Source-impact, Cost, Community	Rating
MLK	% NAAQS: Below current NAAQS Longevity: Long trend history **Max Concentration: Design Value Site** AQI Calculated	**Trends: Tracking control strategies**	**Federal Requirement: NCore Site** Area(1): Urban neighborhood scale site Multi-pollutant: Collocated with multiple parameters	Source-impact: Point, local & mobile source impacts Urban area population exposure Cost: Future need for direct NO_2 monitor	**Critical**
Future expansion of NOx monitoring to Lewes with implementation of the EMP as a member of the OTR					

Lead (Pb)

Current Lead sites

As of 2016 Delaware discontinued FRM PM_{10} lead monitoring at MLK. However, lead monitoring continues as part of both the $PM_{2.5}$ speciation and TSP Heavy Metals monitoring programs.

Historically, Delaware operated lead TSP monitors at multiple locations in New Castle County. Measured ambient concentrations decreased by approximately 94% between 1978 and 1988 due to the change to unleaded gasoline in cars. In 1989, the last year in which samples were collected for compliance with the former NAAQS, 63% of the samples were below the analytical detection limits.

Monitoring Requirements

As of 2016 U.S. EPA has ruled that Lead no longer is required to be monitored for at National Core (NCore) Sites. (Federal Register Vol. 81, No. 59, 3/28/2016) Monitors were eligible to be discontinued after collecting 3 years of data per approval by the Regional Office and upon showing compliance with 40 CFR Part 58.14(c).

Monitoring Network Technology

Monitors

Since the 2015 Network Assessment the State of Delaware has updated $PM_{2.5}$ continuous monitors with a new model, replaced several older ozone analyzers and $PM_{2.5}$ monitors at MLK in the monitoring network.

The table below lists the analyzers critical to meet our monitoring objectives and their age. The manufacturers recommended life expectancy for most monitoring equipment is 7 years. This requires our agency to maintain a replacement schedule to maintain data capture. Many monitors exceed this 7-year recommendation (highlighted in table). $PM_{2.5}$ samplers are being replaced with continuous monitors and the collocated monitor at Lums Pond should be replaced this year (2020). Funding is the most critical component of this replacement schedule and as with every agency has been shrinking over the past several years.

Table 32: Delaware Monitor Ages

	Monitor Age in Years					
Site	**O_3**	**SO_2**	**CO**	**NOx**	**$PM_{2.5}$ FRM**	**$PM_{2.5}$ Continuous**
MLK	9	11	5	10	5-7	4
Bellefonte I					13	
Bellefonte II	4	14				
Brandywine	2					
Newark					13	
Delaware City		14				2
Lums Pond	8	8			13	2
Dover					13	
Seaford	9					2
Killens Pond	9					2
Lewes	2	8				

All monitors used for NAAQS compliance meet EPA requirements as FRM or FEM monitors.

Calibrators

One of the largest concerns is regarding the accurate calibration of all the continuous gas analyzers in the monitoring network. With Delaware's efforts to control source emissions the ambient air concentrations are recording well below the NAAQS. This causes precision point checks to be in the sub-ppb concentration range where a tenth of a ppb incurs % differences outside the established Minimum Quality Objectives. Producing reliable sub-ppb concentrations from standard calibrators is difficult and newer multi-mass flow control calibrators and zero air supplies need to be acquired. All field and laboratory calibrators currently in use meet all EPA specifications and requirements. Many of the calibrators and zero air supplies exceed the recommended 7-year life span.

$PM_{2.5}$ FRM Samplers

The $PM_{2.5}$ FRM samplers are beginning to show their age and we have experienced several malfunctions and missed sample collection. Delaware is in the process of migrating to continuous $PM_{2.5}$ FEM's at all monitoring stations to reduce logistical concerns with manual sample collection. All $PM_{2.5}$ FRM samplers, except for those at Lums Pond and MLK, will be discontinued in the future to reduce the expenditures of sample analysis. The added benefit with continuous monitors is that data is constantly collected and decisions on air quality can be made quickly. The discontinued samplers may be used for parts and any special study that may arise. It is anticipated that a maximum of 4 FRM samplers will be maintained with 3 at MLK fulfilling NCore requirements and 1 at Lums Pond fulfilling collocation requirements

Shelters

Monitoring Shelters and Platform replacements are extremely expensive. However, over time shelters and platforms will deteriorate and no longer be able to support equipment and personnel. Funding is the most critical component of this replacement schedule and as with every agency has been shrinking over the past several years, especially for larger projects.

Table 33: Delaware Monitoring Shelter Ages

Site	Estimated Shelter Age in Years
Brandywine Creek	7
Bellefonte II	25 +
MLK NCore	5
Lums Pond	30
Delaware City (Rt.9)	21
Killens Pond	25
Seaford	22 +
Lewes	23
Platform Sites	
Bellefonte I	21
Newark	21
Dover	21

Data Acquisition System

Delaware transitioned to a digital data acquisition system supplied by DRDAS/Envitech as part of implementation of the NCore program. This system provides increased capabilities in remote communications with the monitoring stations, including the ability to perform remote diagnostic functions and operational checks. The monitoring station Data Acquisition System (DAS) computers are in the process of being updated to standardize the network, support internal IT Department standards, and upgraded DAS software.

Other Support Equipment

All gas cylinders used for monitor calibrations, checks and audits are EPA Protocol I cylinders. Delaware also participates in the AA-PGVP when cylinders are available. Sampling manifolds meet all 40 CFR Part 58 Appendix E requirements for residence time, materials, and probe/inlet heights.

Performance Evaluation/Audit Equipment

Delaware has been also upgrading the instrumentation used in the Performance Evaluation/Audit Program. All audit equipment is independent of field operations, including separate calibrators, zero air sources, and gas standards. Audit equipment is independently certified against NIST standard reference materials annually by outside laboratories.

Table 34: Delaware Performance Evaluation/Audit Equipment Ages

Audit Equipment	Approximate Age
Sabio 2010 calibrator	5
TEI 49i PS ozone calibrator	8
Sabio 1001P zero air source	6
Alicat FP-25 flow meter, temp. & press.	1
Chinook Flow Transfer Standard	11+

Meteorological Equipment

Delaware maintains ultrasonic wind speed/wind direction monitors at multiple sites. Monitors are factory calibrated; checks with portable equipment are performed as needed. The data are used for supplemental information only; any advanced modeling/dispersion analysis uses NOAA/NWS wind data from the nearest NOAA/NWS site.

The NCore site in Wilmington has the most complete meteorological suite of measurements in compliance with EPA NCore requirements and standards. These measurements include Wind Direction, Wind Speed, Ambient Pressure, Ambient Temperature and Percent Relative Humidity.

Cost

Historically, the Program has used equipment well beyond manufacturer estimated life expectancy of seven years. The network requires capital investment for procurement and support of analytical equipment to maintain a replacement schedule. The next major replacement is going to be with equipment shelters.

Consequently, the Program is faced with a large capital expense to upgrade equipment and shelters to current standards. The Program proposes to maintain a replacement program and suggests that equipment be replaced after seven years of service to avoid future data completeness issues. The estimated cost over the next 5 years to maintain the replacement program is approximately $375,000. This cost also includes the addition of equipment due to the new O_3 NAAQS and PAMS requirements.

Results - Summary of Delaware monitoring sites and monitors

Table 35: Delaware Site/Monitor Rating Summaries

Site Name/ID	City, County	Site Start Date	Location Setting	Pollutant/ Method	Monitor Class	Measurement Scale	Rating and Major Criteria from Individual Pollutant Assessment	Site Rating
Killens Pond 10-001-0002	Not in a city Kent County	4/1/1995	Rural	O_3	SLAMS	Neighborhood	**Critical** - Max Concentration: Design Value for Kent County, Measurement Criticality: Removal Bias, Federal Requirement: Rural Background	**Critical**
				~~$PM_{2.5}$ FRM~~	~~SLAMS~~	~~Neighborhood~~	**Discontinued end of 2018**	
				$PM_{2.5}$ FEM continuous	SLAMS	Neighborhood	**Critical -** Max Concentration: Design Value for Kent County, Measurement Criticality: Removal bias, Federal Requirement: Rural Background Site	
				WS/WD	SLAMS	N/A	Marginal – Not required, useful for microscale analysis	
Dover 10-001-0003	Dover Kent County	1/1/1999	Urban	$PM_{2.5}$ FRM	SLAMS	Neighborhood	**Critical** - Max Concentration: Design Value for Kent County, Measurement Criticality: Removal bias, Area Represented: Represents Dover MSA	**Critical**
Brandywine 10-003-1010	Not in a city New Castle	7/1/1994	Rural/Suburban	O_3	SLAMS	Neighborhood	**Critical** - % NAAQS: Close to Current NAAQS, Max Concentration: Design Value, Measurement Criticality: Removal Bias, Meteorological Pattern: Secondary Downwind Direction Wilmington	**Critical**
				WS/WD	SLAMS	N/A	Marginal – Not required, useful for microscale analysis	
Bellefonte II 10-003-1013	Not in a city New Castle	4/1/2001	Suburban	O_3	SLAMS	Neighborhood	**Critical** - % NAAQS: Close to Current NAAQS, Max Concentration: Design Value, Measurement Criticality: Removal Bias, Meteorological Pattern: Primary Downwind Direction Wilmington	**Critical**
				SO_2	SLAMS	Neighborhood	**Credible** – % NAAQS: Below current NAAQS, Longevity: Long Trend History, Community concerns	
Bellefonte I 10-003-1003	Not in a city New Castle	1/1/1999 ($PM_{2.5}$ only)	Suburban	$PM_{2.5}$ FRM	SLAMS	Neighborhood	**Credible** - % NAAQS: Below current NAAQS, Measurement Criticality: Significant Removal bias, Concentration Gradient: Between Wilmington and Chester, PA	Credible

Site Name/ID	City, County	Site Start Date	Location Setting	Pollutant/ Method	Monitor Class	Measurement Scale	Rating and Major Criteria from Individual Pollutant Assessment	Site Rating
MLK 10-003-2004	Wilmington New Castle	1/1/1999	Urban	SO_2	SLAMS/ NCore	Neighborhood	**Critical** - Trend: Used for tracking control strategies, downward trend, Federal Requirement: NCore Site	**Critical**
				CO	SLAMS/ NCore	Middle	**Critical** - Max Concentration: Design Value, Trend: Used for tracking control strategies, Federal Requirement: NCore Site	
				NO_2	SLAMS/ NCore	Neighborhood	**Critical** - Max Concentration: Design Value Site, Trends: Tracking control strategies, Federal Requirement: NCore Site	
				O_3	SLAMS/ NCore	Neighborhood	**Critical** - Federal requirement: NCore site, % NAAQS: Close to current NAAQS, Removal bias	
				$PM_{2.5}$ FRM	SLAMS/ NCore	Neighborhood	**Critical** - Max Concentration: Design Value, significant Measurement Criticality: Removal bias, Trends: Tracking control strategies, Federal Requirement: NCore Site and speciation data	
				$PM_{2.5}$ FEM continuous	SLAMS/ NCore	Neighborhood	**Credible** – AQI, supplemental information	
				$PM_{2.5}$ speciation	SLAMS	N/A	**Critical** - Federal Requirement: Speciation Data	
				PM_{10} FRM	SLAMS/ NCore	Neighborhood	**Critical** - Federal Requirement: NCore Site for PMcoarse calculation, AQI, supplemental information	
				~~Lead~~	~~SLAMS/ NCore~~	~~Neighborhood~~	**Official Monitoring Discontinued in 2016, Monitoring continues in Heavy Metals and Speciation Programs**	
				WS/WD	SLAMS/ NCore	N/A	**Critical** - Federal Requirement: NCore Site	
Newark 10-003-1012	Newark New Castle	12/15/1999	Suburban	$PM_{2.5}$ FRM	SLAMS	Neighborhood	Credible - % NAAQS: Below current NAAQS, Measurement Criticality: Removal bias, Area Represented: Only monitor in Newark area	Credible
Lums Pond 10-003-1007	Not in a city New Castle	1/1/1992	Suburban/Rural	O_3	SLAMS	Neighborhood	**Critical** - % NAAQS: Close to current NAAQS, Federal requirement: transport site	**Critical**
				SO_2	SLAMS	Neighborhood	Credible - Max Concentration: Concentrations between levels at Bellefonte II & DE City, Meteorological Pattern: Secondary downwind direction for DE City oil refinery/industrial complex	
				$PM_{2.5}$ FRM	SLAMS	Neighborhood	**Critical** - Federal Requirement: Transport Site, FRM Collocation requirement with continuous monitor	
				$PM_{2.5}$ FEM continuous	SLAMS	Neighborhood	**Critical** - Federal Requirement: Transport Site	
				WS/WD	SLAMS	N/A	Marginal – Not required	
Route 9 DE City 10-003-1008	Not in a city New Castle	2/1/1992	Suburban	SO_2	SLAMS	Neighborhood	**Critical** - Max Concentration: Highest short-term average, Meteorological Pattern: Downwind major point source, Source impact: Downwind of major SO_2 source	**Critical**
				$PM_{2.5}$ FEM continuous	SLAMS	Neighborhood	Credible – Measurement Criticality: Significant Removal Bias, Source Impact: Point-source impacted site	
				WS/WD	SLAMS	N/A	Credible – Not required but useful for episode analysis	

Site Name/ID	City, County	Site Start Date	Location Setting	Pollutant/ Method	Monitor Class	Measurement Scale	Rating and Major Criteria from Individual Pollutant Assessment	Site Rating
Seaford 10-005-1002	Seaford Sussex	3/1/1990	Suburban/Small Urban	O_3	SLAMS	Neighborhood	**Critical** - % NAAQS: Close to Current NAAQS, Measurement Criticality: Significant Removal Bias, Area represented: Salisbury MSA	**Critical**
				~~$PM_{2.5}$ FRM~~	~~SLAMS~~	~~Neighborhood~~	**Discontinued end of 2018**	
				$PM_{2.5}$ FEM continuous	SLAMS	Neighborhood	**Critical** - Max Concentration: Design Value for Sussex County/Salisbury MSA, Measurement Criticality: Removal bias, Area Represented: Only Site in Sussex County	
				WS/WD	SLAMS	N/A	Marginal – Not required, useful for microscale analysis	
Lewes 10-005-1003	Not in a city Sussex	5/1/1997	Rural/Suburban	O_3	SLAMS	Neighborhood	**Critical** - % NAAQS: Close to Current NAAQS, Max Concentration: Design Value, Measurement Criticality: Removal Bias, Area Represented: Only Coastal Site, seasonal population exposure, Special Considerations: Population growth expected to continue, correlation with some sites declining	**Critical**
				SO_2	SLAMS	Neighborhood	**Critical –** Federal Requirement: Only monitor for Salisbury MSA	
				WS/WD	SLAMS	N/A	Marginal – Not required, useful for microscale analysis	

References

Ambient air Monitoring Network Assessment Guidance, Analytical Techniques for Technical Assessments of Ambient Air Monitoring Networks Contract No. EP-D-05-004, Work Assignment No. 2-12, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, North Carolina.

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Delaware Ambient Air Monitoring Network Description for Criteria Pollutants, Division of Air Quality, Department of Natural Resources and Environmental Control, New Castle, DE, June 30, 2019.

Designing a Network Assessment for an Ambient Air Monitoring Program, OAQPS/AQAD/AQAG, http://www.epa.gov/ttnamti1/network-assessment.html.

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Network Assessment Analyses and Tools Documentation, Michael Rizzo, OAQPS/AQAD/AQAG, March 1, 2010.

Network Assessment Goals, Presented at MARAMA 2010 Monitoring Committee Training Workshop, Kevin Cavender, Ambient Air Monitoring Group, EPA/OAQPS, February 23, 2010.

NOAA climatological data, http://www.ncdc.noaa.gov/cdo-web/datatools.
U. S. Census Bureau, http://factfinder.census.gov

Appendix I Monitoring Network History Tables

The following pages contain tables of historical monitoring sites by county and pollutant for various periods.

Pre-1969

Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-1001	Kent	Bombay Hook	x	x	x							Benzene sol. organics, beta radiation
10-003-0001	New Castle	Claymont Fire Station	x									Sulfation rate, fabric fading, rubber deterioration
10-003-1001	New Castle	UD Farm	x	x	x							TSP ammonium, sulfate, nitrate, beta radiation
10-003-4001	New Castle	1000 King St. - Public Bldg	x	x								TSP ammonium, sulfate, nitrate

1969 – 1979

Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-0001	Kent	Dover - police station	x		x							WS/WD
10-001-1001	Kent	Bombay Hook	x	x	x							TSP ammonium, sulfate, nitrate
10-003-0002	New Castle	Newark - UD Ag farm	x		x							soil index (COH)
10-003-0004	New Castle	Ferris School	x		x							soil index (COH)
10-003-0005	New Castle	Old SPCA property	x		x							soil index (COH)
10-003-0006	New Castle	Delaware City - Gov. Bacon Center	x		x							soil index (COH)
10-003-0007	New Castle	Mt Pleasant farm	x		x							soil index (COH)
10-003-0010	New Castle	Kirkwood Hwy - NCC Eng. Bldg	X		x							soil index (COH)
10-003-0011	New Castle	Lombardy School	x		x							soil index (COH)
10-003-0012	New Castle	St Georges - Rte 72 and Rte 378	x		x							soil index (COH)
10-003-1001	New Castle	Newark - UD Ag farm	x	x	x		x					TSP ammonium, sulfate, nitrate
10-003-1002	New Castle	Naamans Rd	X		X							soil index (COH)
10-003-1003	New Castle	Bellefonte - River Rd. Park	x		x							soil index (COH)
10-003-1004	New Castle	Wilmington - Marine Terminal Lumber Rd			x							soil index (COH)
10-003-2001	New Castle	New Castle - Ommelanden	x		x							Soil index (COH), (Rud)
10-003-2002	New Castle	Wilmington - 12th and King St.	x	x								soil index (COH), TSP ammonium sulfate, nitrate
10-003-2003	New Castle	Wilmington - Walnut & Taylor sts	x	x	x							
10-003-3001	New Castle	Claymont - Woods-Haven/Kruse	x		x							soil index (COH)
10-005-0001	Sussex	Milford Elementary	x		x							
10-005-1001	Sussex	Seaford - water tower	x		x							

1980 – 1989

Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-0001	Kent	Dover - police station	x		x			x				WS/WD
10-003-0002	New Castle	Newark - UD Ag farm	x		x							
10-003-0003	New Castle	Newark - Hudson Bldg Ogletown Rd	x									
10-003-0006	New Castle	Delaware City - Gov. Bacon Center	x		x							WS/WD
10-003-0010	New Castle	Kirkwood Hwy - NCC Eng. Bldg	X			x						
10-003-0070	New Castle	Summit - Lorewood Rd						x				
10-003-1003	New Castle	Bellefonte - River Rd. Park	x		x			x				
10-003-1004	New Castle	Wilmington - Marine Terminal			x							
10-003-1005	New Castle	Wilmington - UD Wilcastle Center	x	x								
10-003-1006	New Caslte	Wilmington - 3rd & Union fire stn	x						x			
10-003-2001	New Castle	New Castle - Ommelanden	x		x	x						
10-003-2002	New Castle	Wilmington - 12th and King St.	x	x	x	x	x		x			Total NMOC, Methane
10-003-3001	New Castle	Claymont - Woods-Haven/Kruse	x	x	x	x		x				WS/WD
10-005-1001	Sussex	Seaford - water tower	x		x			x				

1990 - 1999

Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-0001	Kent	Dover - police station	x		x			x				WS/WD
10-001-0002	Kent	Killens Pond						x		x		WS/WD
10-003-0006	New Castle	Delaware City - Gov. Bacon Center			x				x			WS/WD
10-003-0018	New Castle	Lums Pond						x				
10-003-1003	New Castle	Bellefonte - River Rd. Park	x		x			x				
10-003-1006	New Castle	Wilmington - 3rd & Union fire stn	x						x			
10-003-1007	New Castle	Lums Pond			x		x	x	x	x		PAMS VOCs, WS/WD
10-003-1008	New Castle	Delaware City - Rte 9			x	x						
10-003-1010	New Castle	Brandywine Creek State Park						x				
10-003-2002	New Castle	Wilmington - 12th and King St.			x	x	x		x			
10-003-3001	New Castle	Claymont - Woods-Haven/Kruse			x	x	x	x	x			WS/WD
10-005-1002	Sussex	Seaford - Virginia Ave			x			x	x			

2000 – 2009

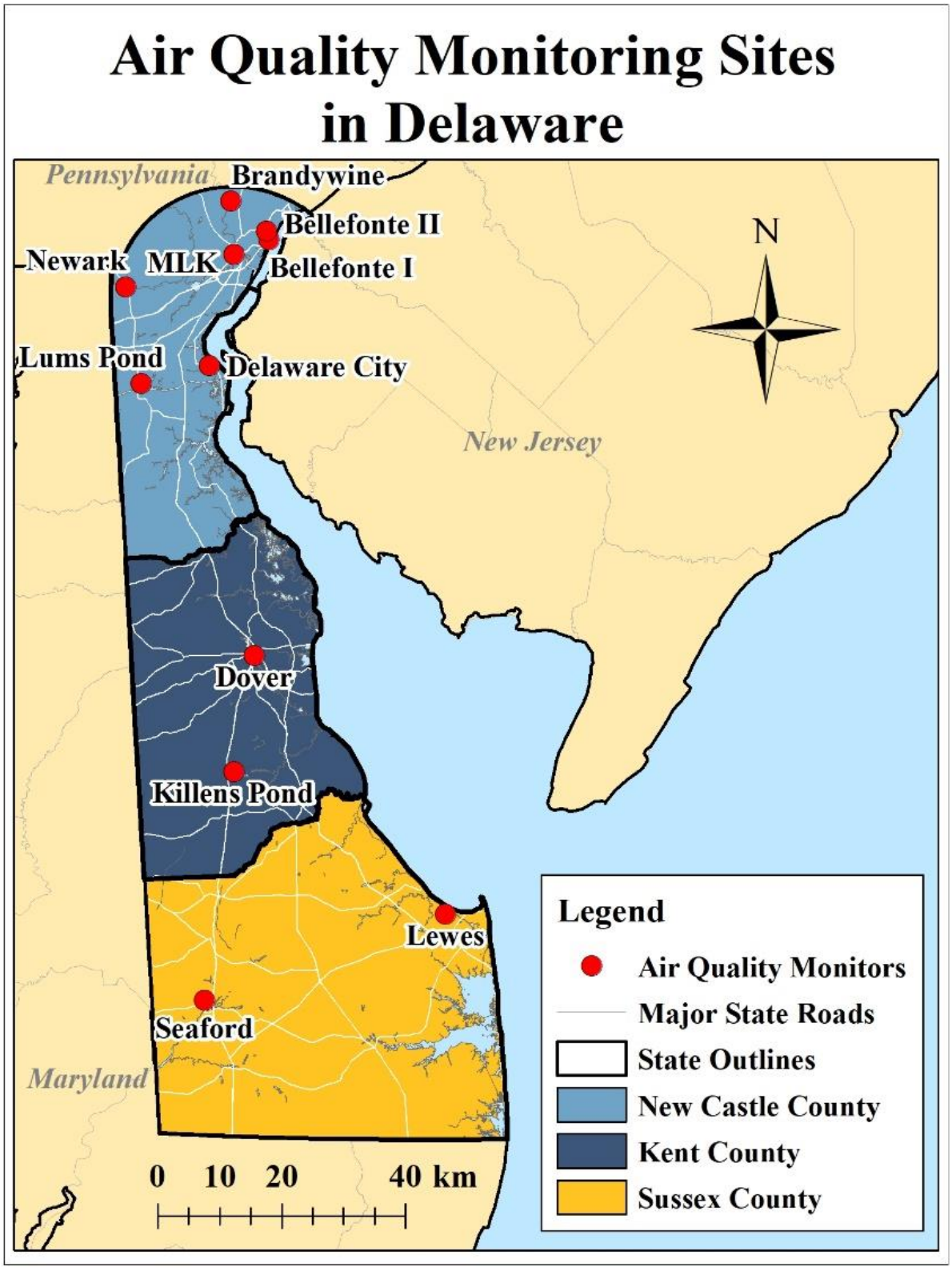
Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-0002	Kent	Killens Pond						x		x		WS/WD
10-001-0003	Kent	Dover - Water St.								x	x	
10-003-1003	New Castle	Bellefonte - River Rd. Park			x		x	x	x	x		
10-003-1007	New Castle	Lums Pond			x			x		x		PAMS VOCs, WS/WD
10-003-1008	New Castle	Delaware City - Rte 9			x	x						VOCs
10-003-1010	New Castle	Brandywine Creek State Park						x				
10-003-1012	New Castle	Newark - UD North Campus								x		
10-003-2004	New Castle	Wilmington - MLK Blvd		x	x	x	x		x	x	x	VOCs, carbonyls
10-005-1002	Sussex	Seaford - Virginia Ave						x		x		WS/WD
10-005-1003	Sussex	Lewes - UD campus						x				WS/WD

2010 – 2015

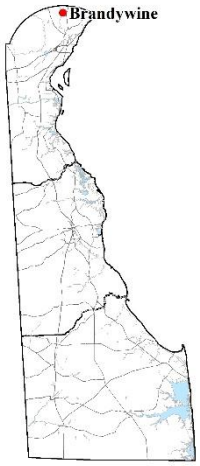
Site ID	County	Name	TSP	TSP metals/ lead	SO_2	CO	NO_2	Ozone	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ Speciation	Other
10-001-0002	Kent	Killens Pond						x		x		WS/WD
10-001-0003	Kent	Dover - Water St.								x		
10-003-1003	New Castle	Bellefonte I - River Rd. Park								x		
10-003-1013	New Castle	Bellefonte II - Bellevue St. Park			x			x				
10-003-1007	New Castle	Lums Pond						x		x		
10-003-1008	New Castle	Delaware City - Rte 9			x	x						VOCs, WS/WD
10-003-1010	New Castle	Brandywine Creek State Park						x				
10-003-1012	New Castle	Newark - UD North Campus								x		
10-003-2004	New Castle	Wilmington - MLK Blvd		x	x	x	x		x	x		trace SO2, trace CO, Black Carbon, VOCs, carbonyls, WS/WD
10-005-1002	Sussex	Seaford - Virginia Ave						x		x		WS/WD
10-005-1003	Sussex	Lewes - UD campus						x				WS/WD

Appendix II Delaware Monitoring Network Site Descriptions

The following pages contain additional site-specific information on all active SLAMS monitoring sites in Delaware.



Site: Brandywine (BCSP)



AQS Site ID: 10-003-1010
State: Delaware
County: New Castle
Address: Brandywine Creek State Park, Wilmington

Latitude: 39.8172
Longitude: -75.5639

Spatial Scale: Neighborhood
Area Represented: Philadelphia-Camden-Wilmington,
(MSA) PA-NJ-DE-MD

Year Established: 1994

Monitored Parameters

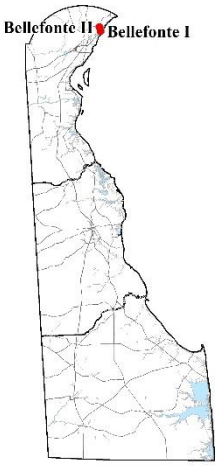
O_3	Ozone
WS / WD	Wind Speed & Direction
T / Rh	Temperature & Relative Humidity

Site Description
The Brandywine site is located in Brandywine Creek State Park and was established when a secondary downwind site in Claymont was discontinued due to changes in nearby land use and ownership. This is a neighborhood scale site for O_3 monitoring. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives
Population exposure, maximum concentration, O_3 NAAQS compliance, and trends.

Planned Changes through 2020
No changes planned.

Site: Bellefonte I (Platform) & II



AQS Site ID: BF I – 10-003-1003
BF II – 10-003-1013
State: Delaware
County: New Castle
Address: BF I – River Road Park
BF II – Bellevue State Park

Latitude: BF I – 39.7613
BF II – 39.7739
Longitude: BF I – -75.4920
BF II – -75.4965

Spatial Scale: Neighborhood
Area Represented: Philadelphia-Camden-Wilmington,
(MSA) PA-NJ-DE-MD

Year Established: BF I – 1969
BF II – 2001

← Bellefonte II

↓ Bellefonte I

Monitored Parameters

Bellefonte I	**$PM_{2.5}$**	Particulate Matter: 24-hour (Microns < 2.5)
Bellefonte II	**O_3**	Ozone
	SO_2	Sulfur Dioxide

Site Description

Bellefonte was originally established in 1969 to monitor O_3 (primary downwind direction from Wilmington) and SO_2. $PM_{2.5}$ was added in 1999. When changing site characteristics began to interfere with ozone monitoring, a new site (Bellefonte II) was established in 2001, less than a mile to the north. The O_3 and SO_2 monitors were relocated to the new site, while the $PM_{2.5}$ monitor remained at the original site to provide data continuity. Both sites meet all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives

Monitoring objectives are NAAQS compliance, population exposures, and trends. Bellefonte II is the O_3 maximum downwind concentration site for Wilmington. The SO_2 monitor is sited for general population exposure and trends, with major point sources located to the northeast in Marcus Hook, PA and to the south in Edgemoor.

Planned Changes through 2020

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM at Bellefonte I when resources become available.

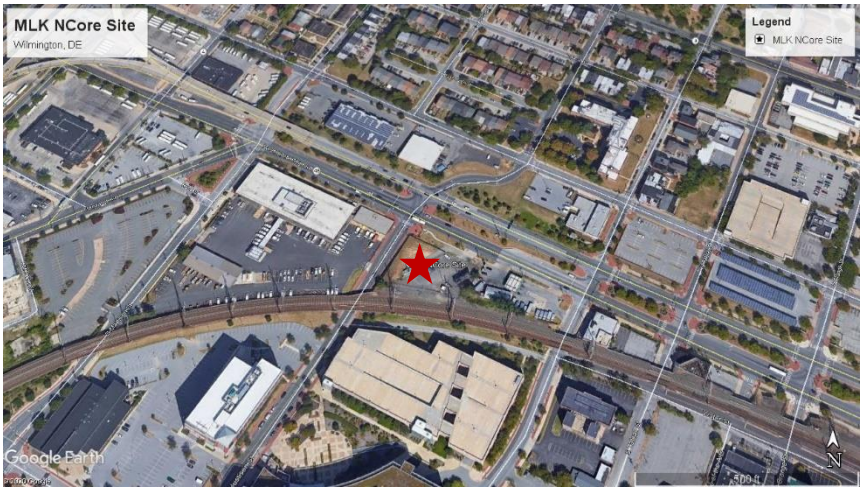
Site: MLK NCore (Wilmington)

AQS Site ID: 10-003-2004
State: Delaware
County: New Castle
Address: Justison St. & MLK Blvd., Wilmington

Latitude: 39.7395
Longitude: -75.5575

Spatial Scale: Neighborhood
Area Represented: Philadelphia-Camden-Wilmington,
(MSA) PA-NJ-DE-MD

Year Established: 1999



Monitored Parameters

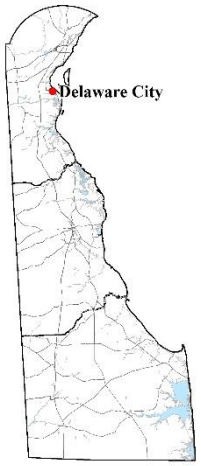
O_3	Ozone
SO_2	Sulfur Dioxide
CO	Carbon Monoxide
NO_2	Nitrogen Dioxide
NO_y	Total Reactive Oxides of Nitrogen
$PM_{2.5}$, PM_{10}, $PM_{10-2.5}$	Particulate Matter: Hourly & 24-hour (Microns < 2.5, 10, & Coarse =10-2.5)
$PM_{2.5}$ Spec.	Particulate Matter 2.5 Speciation
WS / WD	Wind Speed & Direction
T / Rh	Temperature & Relative Humidity

Site Description
The MLK site is within the city of Wilmington, DE at the intersection of Justison St. and MLK Blvd. It replaced another urban site at 12th and King Streets that had operated at that location for over 20 years and was discontinued due to a change in land ownership. The MLK site is the state National Core (NCore) site and represents urban population exposure to multiple pollution sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria

Monitoring Objectives
Population exposure, maximum concentration, NAAQS compliance, NCore, and trends.

Planned Changes through 2020
Implementation of the PAMS program by summer of 2021 will require additional equipment including: PAMS Auto GC, Carbonyl Sampler, Ceilometer, Pyrometer, and Tipping Bucket Rain Gauge.

Site: Delaware City (Rt 9)



AQS Site ID: 10-003-1008
State: Delaware
County: New Castle
Address: Route 9, Delaware City

Latitude: 39.5777
Longitude: -75.6306

Spatial Scale: Neighborhood
Area Represented: Philadelphia-Camden-Wilmington,
(MSA) PA-NJ-DE-MD

Year Established: 1992

Monitored Parameters

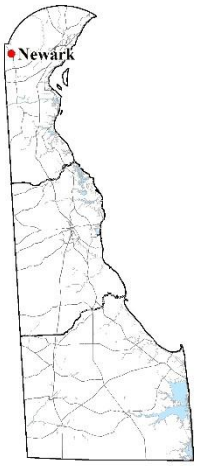
SO_2	Sulfur Dioxide
$PM_{2.5}$	Particulate Matter: Hourly (Microns < 2.5)
WS / WD	Wind Speed & Direction
T / Rh	Temperature & Relative Humidity

Site Description
The Delaware City site was established at a location along Route 9 that is between the Delaware City industrial complex and the nearest populated area (Delaware City) in the predominant downwind direction. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives
This monitoring site is a stationary source-impacted site for SO_2. The monitoring objectives are population exposure, compliance with the NAAQS, and trends.

Planned Changes through 2020
No changes planned.

Site: Newark (Platform)



AQS Site ID: 10-003-1012
State: Delaware
County: New Castle
Address: University of Delaware North Campus, Newark

Latitude: 39.6916
Longitude: -75.7617

Spatial Scale: Neighborhood
Area Represented: Philadelphia-Camden-Wilmington,
(MSA) PA-NJ-DE-MD

Year Established: 1999

Monitored Parameters

$PM_{2.5}$ Particulate Matter: 24-hour (Microns < 2.5)

Site Description

The Newark site is a platform only and was established to understand $PM_{2.5}$ concentrations in the Newark area and potentially transported $PM_{2.5}$ from upwind areas to the west. It is a $PM_{2.5}$ neighborhood scale site. The location is suburban and generally impacted by mobile sources and regional transport. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

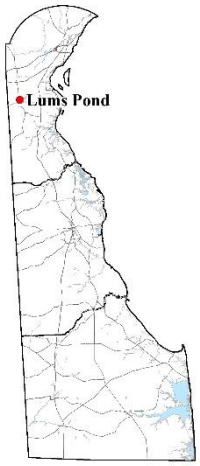
Monitoring Objectives

Population exposure, $PM_{2.5}$ NAAQS compliance, regional transport, and trends.

Planned Changes through 2020

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM when resources become available.

Site: Lums Pond

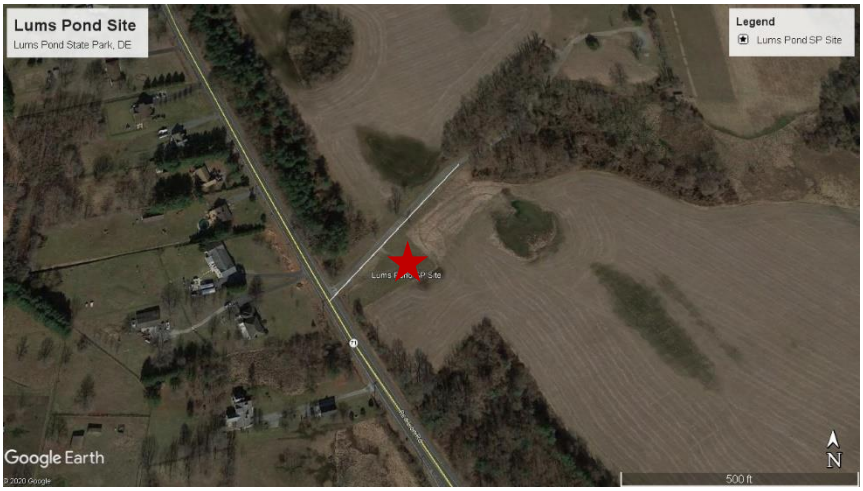


AQS Site ID: 10-003-1007
State: Delaware
County: New Castle
Address: Lums Pond State Park, Bear

Latitude: 39.5513
Longitude: -75.7320

Spatial Scale: Urban
Area Represented: Not in and urban area
(MSA)

Year Established: 1991



Monitored Parameters

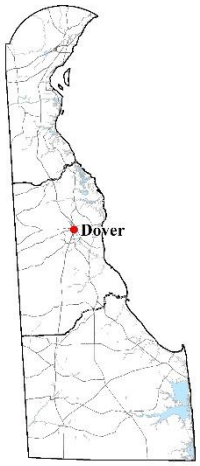
O_3	Ozone
SO_2	Sulfur Dioxide
$PM_{2.5}$	Particulate Matter: Hourly & 24-hour (Microns < 2.5)
WS / WD	Wind Speed & Direction
T / Rh	Temperature & Relative Humidity

Site Description
The Lums Pond site was originally neighborhood scale located in a general upwind direction from Wilmington. The scale of representation was changed to Urban (4 – 50 km) to reflect the background and transport monitoring objectives. The immediate area is rural. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives
The site objectives for O_3 are upwind background for the Wilmington area, population exposure, NAAQS compliance, and trends. This site was originally planned to monitor O_3 transported into Delaware from the Baltimore/Washington area, and continues to serve this purpose. The SO_2 monitor was added in 2000 to detect impacts from major point sources directly to the east. $PM_{2.5}$ monitoring began in 1999 as both a regional transport and general population exposure site, as well as for NAAQS compliance.

Planned Changes through 2020
Replacement of the $PM_{2.5}$ FRM retained to meet collocation with FEM requirements, as resources become available.

Site: Dover (Platform)

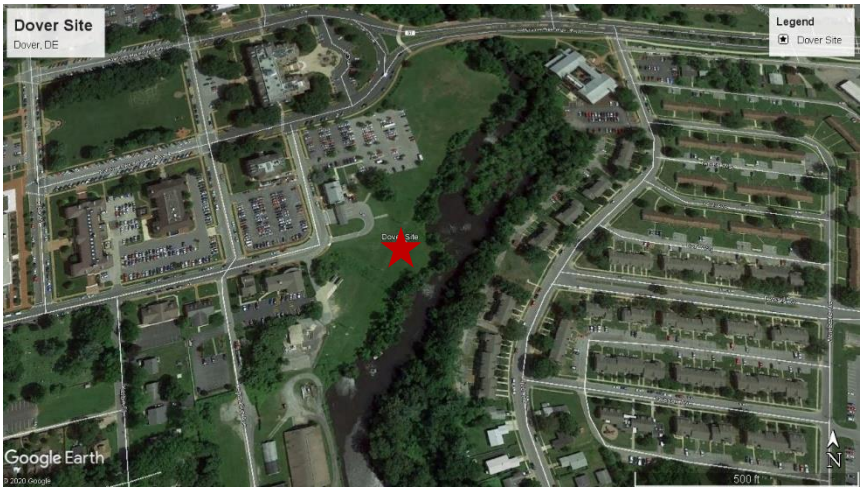


AQS Site ID: 10-001-0003
State: Delaware
County: Kent
Address: Water St., Dover

Latitude: 39.1556
Longitude: -75.5182

Spatial Scale: Neighborhood
Area Represented: Dover
(MSA) DE

Year Established: 1999



Monitored Parameters

$PM_{2.5}$ Particulate Matter: 24-hour (Microns < 2.5)

Site Description

The Dover site is a platform only and was established to understand fine particulate concentrations in the Dover area. It is a neighborhood scale site representative of the Dover MSA impacted by a combination of source types including mobile, large and small point sources. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives

Population exposure, $PM_{2.5}$ NAAQS compliance, and trends.

Planned Changes through 2020

Replace existing $PM_{2.5}$ FRM with new $PM_{2.5}$ FEM when resources become available.

Site: Killens Pond

AQS Site ID: 10-001-0002
State: Delaware
County: Kent
Address: Killens Pond State Park, Felton

Latitude: 38.9867
Longitude: -75.5568

Spatial Scale: Urban
Area Represented: Not in an urban area
(MSA)

Year Established: 1995

Monitored Parameters

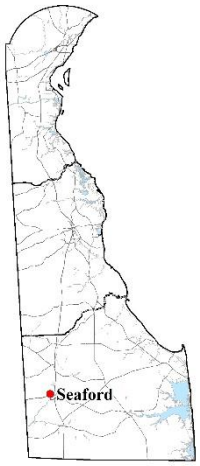
O_3	Ozone
$PM_{2.5}$	Particulate Matter: Hourly (Microns < 2.5)
WS / WD	Wind Speed & Direction

Site Description
The Killens Pond site is located in a rural area that is part of Killens Pond State Park. It was established to understand background concentrations of O_3 and $PM_{2.5}$. The scale of representation was changed to Urban (4 – 50 km) to reflect the background monitoring objective. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives
Background concentrations, NAAQS compliance, and trends.

Planned Changes through 2020
No changes planned.

Site: Seaford



AQS Site ID: 10-005-1002
State: Delaware
County: Sussex
Address: 350 Virginia Ave., Seaford

Latitude: 38.6539
Longitude: -75.6106

Spatial Scale: Neighborhood
Area Represented: Salisbury,
(MSA) MD-DE

Year Established: 1990

Monitored Parameters

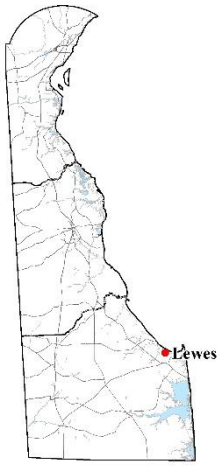
O_3	Ozone
$PM_{2.5}$	Particulate Matter: Hourly (Microns < 2.5)
WS / WD	Wind Speed & Direction

Site Description
The Seaford site was originally located to monitor pollutant concentrations in the Seaford area. The original site was located further south, near the Seaford water tower. It was relocated to the present location in 1990 due to deteriorating conditions at the original site. The current site is neighborhood scale and is suburban. The site is impacted by local point sources, mobile sources, and regional transport. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives
Population exposure, NAAQS compliance, and trends.

Planned Changes through 2020
No changes planned.

Site: Lewes



AQS Site ID: 10-005-1003
State: Delaware
County: Sussex
Address: University of Delaware: College of Earth, Ocean, & Environment - Hugh R. Sharp Campus, Lewes
Latitude: 38.7791
Longitude: -75.1632

Spatial Scale: Neighborhood
Area Represented: Salisbury,
(MSA) MD-DE

Year Established: 1991

Monitored Parameters

O_3	Ozone
SO_2	Sulfur Dioxide
WS / WD	Wind Speed & Direction
T / Rh	Temperature & Relative Humidity

Site Description

The Lewes site is neighborhood scale established to understand O_3 concentrations in the coastal area where population increases significantly in the summer months. SO_2 was added in 2012 in response to the new SO_2 NAAQS monitoring requirements. It is representative of the coastal Sussex County area. This site meets all EPA 40 CFR Part 58 App D and E siting criteria.

Monitoring Objectives

Population exposure, NAAQS compliance, and trends.

Planned Changes through 2020

No changes planned. A NOx monitor will be added as part of EMP when implemented.